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THE CONSERVATION OF OUR OYSTER SUPPLY.

By ROBERT F. WALSH.

"OYSTER culture, properly so called, the production of spat by aid of artificial methods, has never been resorted to in this country." And "as the scarcity of seed is one of the greatest difficulties now encountered by the oyster planter, this subject offers an interesting field for investigation."

These statements occur in the Report of the United States Commissioner of Fish and Fisheries for the year ending June 30, 1889; and as the propagation of spat by artificial means has not been resorted to since that time, it will be interesting to examine the general conditions of our oyster supply, and, from ascertained results in foreign waters, consider whether or not such methods would tend toward restocking our depleted oyster beds, or economically increasing the oyster supply.

In the consideration of this subject it will be well, first, to give a brief, general account of the conditions of the existing, working, and outworked oyster beds; and, having ascertained these conditions, as nearly as possible, and made some necessary comparisons, we can more easily consider the advisability of raising spat by artificial methods. The natural oyster of America can not continue to be produced in such abundance as we have been accustomed to find it. The beds of South Carolina have practically given out; the famous oyster beds of Maryland and Virginia —in the Chesapeake Bay region, which Captain Collins calls "the most important oyster region of the world"—are being so depleted of oysters that the "gravest apprehension" is caused as to their future; and only in Connecticut has there been a marked increase, both in the acreage of oyster beds and oyster production.

FIG. 1.—AN OYSTER FLAT IN SOUTH CAROLINA, SHOWING EXTENT OF RACCOON AREA.

and in the methods, number of persons, and capital employed for the building up of the industry.

In the present conditions an oyster famine is not a far-away nor impossible contingency. We have been large consumers of oysters, and we did not sow where we had reaped. Luckily, this condition of affairs attracted the serious attention of the United States Fish and Fisheries Commission; exhaustive investigations were made, and finally, in the autumn of 1891, Mr. Bashford Dean proceeded to France, under instructions from the United States Commissioner of Fish and Fisheries, and there, at the great French homes of oyster culture—around Arcachon and Auray—he examined the French methods of artificial culture, his observations being chiefly made so as to be as pertinent as possible to the conditions of American waters. I can not, however, agree with some of the statements which Mr. Dean makes in the introduction to his report. He says that, considering the condition and methods of oyster culture in France, it is apparent that in this country "all costly methods of cultivation could have proved of little practical value." Prof. W. K. Brooks, Mr. E. C. Blackford, and other authorities are positive in their statements to the contrary. For instance, in his report to the Legislature of New York State, in 1887, Mr. Blackford says: "The rapid deterioration of the natural growth of oyster beds . . . has made it absolutely necessary that the artificial propagation of the oyster should be encouraged to prevent its entire extermination." But, as it will be necessary to enter into this subject more fully later, I shall now briefly examine the general conditions of the industry as it exists to-day, making short historical and comparative allusions as I proceed.

Taking the oyster beds in the order in which I have placed them, we shall first examine those of South Carolina. "The entire coast margin" of this State is well provided with natural beds; but, says Mr. Dean, "they are strangely unlike the natural beds occurring further northward." In this region the oyster is found on the margin of the shore in positive reefs, part of which are at low tide exposed—so that the oysters live almost "as much in the air as in the water." These ledges are formed of curious clusters—those oysters which are on the top being called "raccoons," because of their peculiar shape. These oysters can barely be said to live, and are in their present condition utterly unfit for the table.

Prof. Ryder says that the cause of this peculiar clustering is that, because of the muddy and unhealthy condition of the bottom in the deeper water, the oysters of South Carolina cling to the shore line and there build upon one another, generation after generation, until sometimes ledges are formed over ten feet in

height. This crowding together prevents individual development, and consequently millions upon millions of oysters are lost to the people of this country in this one State alone. That the "planting" of "raccoon" seed in the deeper waters for cultivation would be profitless is shown by the natural growth of the oysters themselves in the marginal waters. They would soon become asphyxiated in the soft, silting mud bottom which occurs along the entire coast line of this State. But it has been demonstrated that, under almost as unfavorable conditions, excellent and healthy grounds could be prepared at comparatively slight cost, as has been so successfully done in Connecticut; and Mr. Dean shows conclusively that the "raccoons" might be scattered in "marginal waters about a fathom in depth," with an almost certain prospect of successful development. Curiously enough, in his article on the Biology of the Oyster Grounds of South Carolina, he *advocates* the artificial collection and rearing of spat.

There are miles upon miles of these "raccoon" ledges, and even islands which have been formed by the "raccoons," upon this part of the coast; they contain enough seedlings to stock the entire Atlantic coast, and a very little enterprise or judicious State interference would undoubtedly restore to South Carolina and the oyster-consuming population of the United States what must have been in ages past one of the most prolific natural oyster beds of the world.

The conditions in Chesapeake Bay are much more favorable than those which we have just considered. Here Nature has created, as Captain Collins has truly said, the most perfect oyster ground in the universe. But, as is the case with the prosecution of many other fisheries, man—either in his greed or ignorance, or both—has outraged a bountiful Nature by continuously fishing for the oysters without replanting, and as a consequence this remarkable oyster region is becoming rapidly less important.

In his report, Captain Collins accounts for the recklessness of the fishermen and oystermen in this way: "The general belief (in the Chesapeake Bay region) has been, that the natural wealth of the oyster beds is inexhaustible," and that, "trained from childhood to look upon the oyster grounds as their patrimony, . . . it is perhaps not remarkable that the fishermen of the Chesapeake have bitterly, and to this time successfully, opposed all attempts at legislation intended to convey proprietary rights in the grounds."

Illustrating their reliance upon Nature, the report just referred to quotes the following paragraph from a local publication: "The value of the oyster business alone to southeast Virginia is nearly $2,500,000 per annum. It is a crop constantly harvested, except in the months of May to August inclusive, and

Fig. 2.—Raccoons clustered on the Piling of a Wharf at High-Water Mark. Sullivan's Island, South Carolina.

Fig. 3.—An Oyster Ledge, showing Living Raccoon Oysters fringing the Water.

is as constantly replenished by the bountiful hand of Nature." I have already shown how this same greed and ignorance of the Chesapeake oystermen have jeopardized not only their oyster supply but also their means of livelihood.

As a matter of fact it is in this erroneous assumption that lie the truth and reason for the apparent diminution of not only the oyster supply, but also the supplies of other fish food in our waters. Nature distinctly claims her rights when she demands that we must sow where we have reaped; and in this lies the true axis for the more satisfactory revolution of our fish and other food products.

I shall now pass to the third oyster ground which I have mentioned, and shall more pleasurably outline the prosperous conditions existing in Connecticut. Prior to 1784 no restrictions were placed upon the oyster fishery of this State; it was perfectly free, and as a consequence the beds soon became depleted. In that year the Legislature passed an enactment empowering every town of the State "to make rules and ordinances for regulating the fisheries of clams and oysters within their respective limits." This, however, did not materially aid in rehabilitating the beds; but the law continued in operation for seventy-one years—1855—when, the condition of the oyster grounds was so poor, a law was passed enabling private individuals to obtain two acres of ground for the *cultivation* of oysters. This was the first step in the right direction. The private owners discovered that, instead of planting small oysters, they could collect spat artificially on shells and other objects; this discovery "led to an extension of deep-water planting," and it was undeniably the source of the present prosperity of the Connecticut oyster fisheries.

Captain Collins says that at first the planting was confined to shallow waters; but, in 1865, many beds were planted "in as much as twenty feet of water." And so the development increased until 1874, when steam was introduced for dredging. In 1881 additional legislation became necessary, in order to enable the owners of private grounds to enlarge their territories, as they complained that the cultivation of oysters in deep waters required much additional and costly apparatus. And since that time the number of acres of oyster grounds owned by individuals —according to the Connecticut State Shellfish Commission—has increased from 33,987 acres in 1881 to 70,132 in 1889, of which 15,400 were planted. Apart from this calculation there are 19,911 acres of public oyster grounds—which, however, can not be dredged by steam.

In 1889 the value of oysters from natural beds amounted to only $31,305, whereas the yield of the cultivated beds was sold for $1,040,372. So that, if Connecticut relied upon her natural beds,

as do they in Maryland and Virginia, her oyster fisheries would have been a practical failure, as they threaten to be in the Chesapeake, unless there is speedy and judicious State legislation.

As a matter of fact, the present condition of affairs in the Chesapeake points ominously to a not far distant appeal from the fishermen of that region to the General Government to assist them in rehabilitating their oyster grounds. Such a contingency is at all times best avoided; but in this case I have shown, by comparison, that all that is needed in the Chesapeake region, to insure a renewed prosperity of the oyster fishery, is judicious State legislation in the direction of conveying proprietary rights to individuals or companies for the purpose of planting and cultivating the oyster. This plan has already been attempted in the Chesapeake, but has so far been successfully resisted by the fishermen. The prosperity of the Connecticut fisheries is entirely owing to the State enactments conferring proprietary rights; and there can not be a doubt but that similar legislation in Maryland and Virginia would bring about a return of prosperity to the Chesapeake oyster fisheries.

The usual method employed in Connecticut for the collection of spat is to first clean the ground by dredging and then cover it with shells, to which the spat will adhere, nearly 7,500,000 bushels of shells being used for this purpose during the past five years. "It is estimated that twenty-five or thirty adult oysters produce enough eggs each season to equal the annual product of Connecticut waters." So that, were it not for the starfish and other enemies which infest this coast, the supplies of food oysters would outrival in quantity the hundreds of thousands of acres covered by the now useless "raccoons" of South Carolina. No judicious expense is spared to make the oyster beds of Connecticut prolific: if they are too muddy, as are those of South Carolina, they are easily "made," by placing one hundred to two hundred tons of gravel over each acre, and the report of the commissioner states that "this system has produced excellent results."

Of course, there are other oyster grounds on the Atlantic coast besides those which I have mentioned—notably the famous Shrewsbury River beds; but they are not so extensive, nor do they so particularly affect the question, by comparison, of the advisability of adopting artificial propagation. And now, having briefly explained the conditions of our oyster grounds, we are brought face to face with the statement which prefaces this article, namely: "As the scarcity of seed is one of the greatest difficulties now encountered by the oyster planter," would the propagation of spat by artificial means profitably assist in rehabilitating our depleted grounds?

As I have already mentioned, Mr. Blackford not only thinks

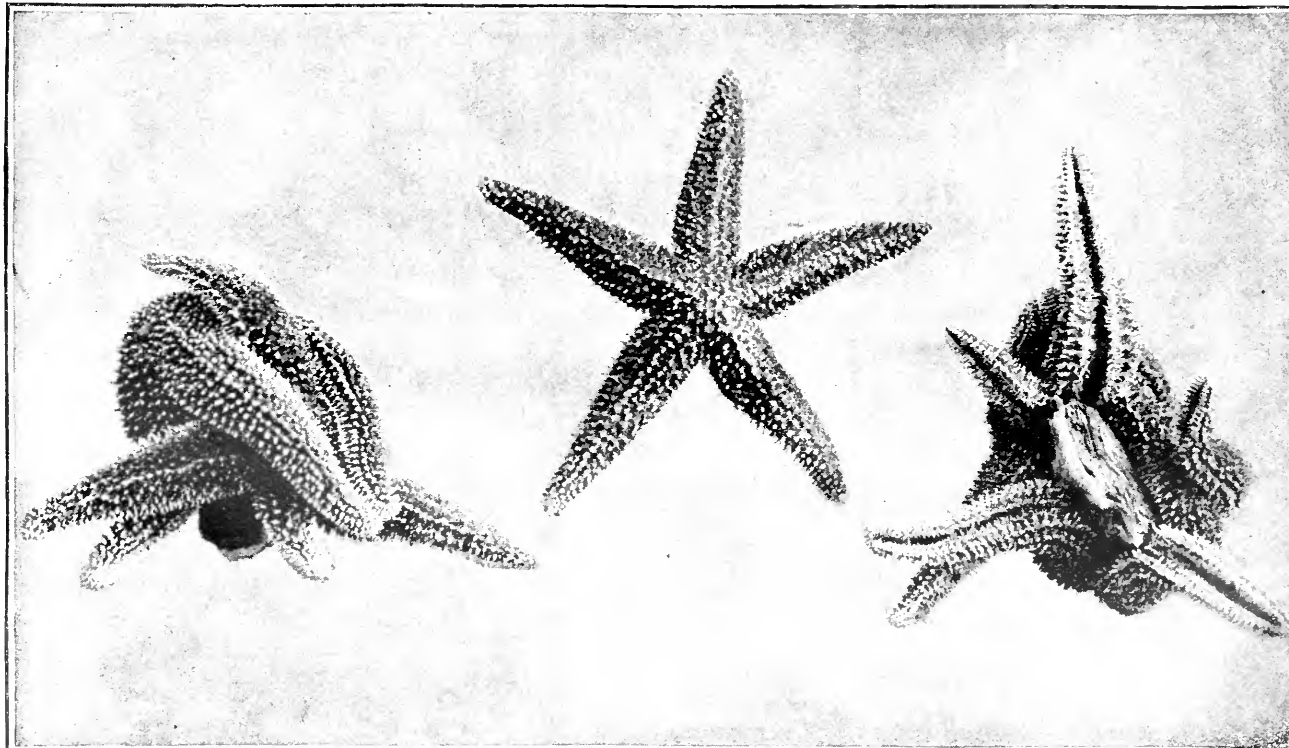

Fig. 4.—Starfishes destroying an Oyster.

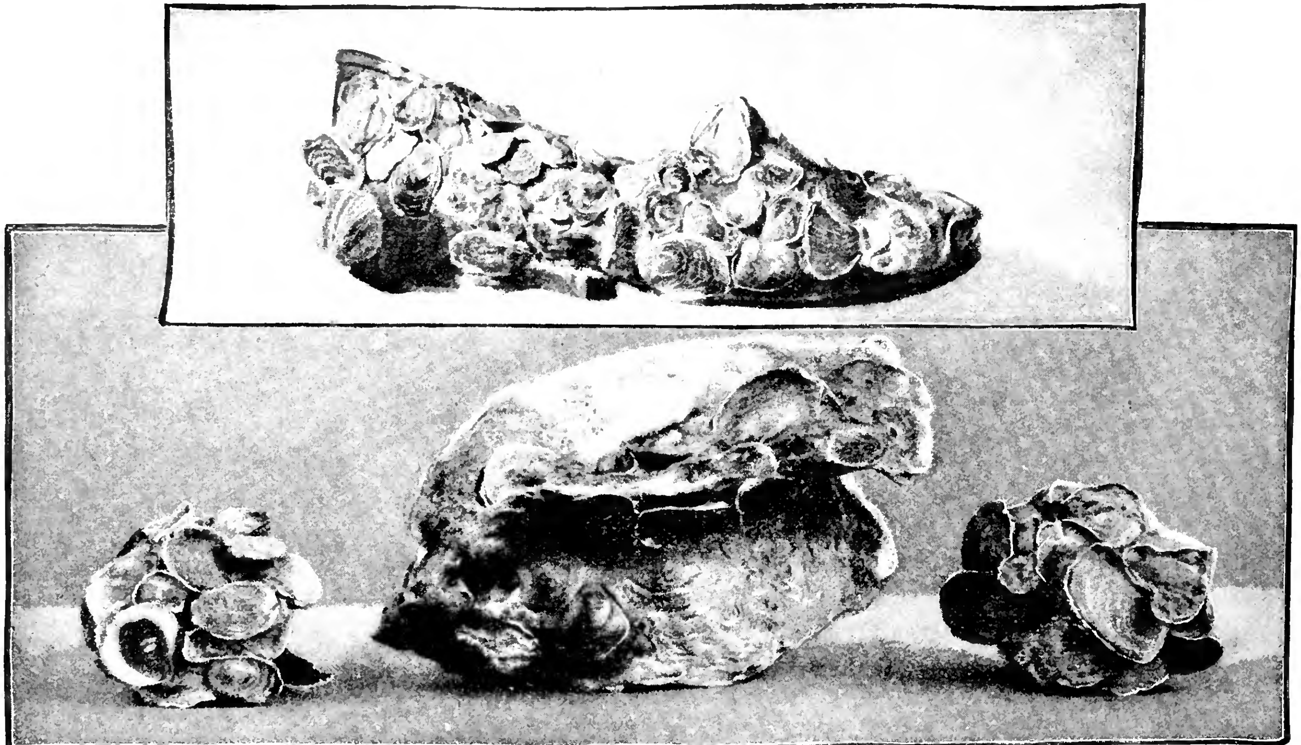

Fig. 5.—Young Oysters (Three to Six Months Old) set on Shells and an Old Rubber Shoe. From a photograph.

so, but says that the artificial propagation of the oyster "is absolutely necessary" to prevent its "entire extermination." In a report to the General Assembly of Maryland in 1887, Prof. Brooks also advocates the introduction of artificial propagation in these waters; Captain Collins suggests that such an experiment would be valuable; and Mr. Dean says that, although in this country "all costly methods of cultivation could have proved of little practical value, . . . enough has been said in this connection to show the necessity in practical oyster culture of collecting spat on floating collectors and of allowing it to attain, before planting, a considerable size." And notwithstanding all this testimony, Mr. Richard Rathbun, in the Report of the Commissioner of Fish and Fisheries for the year ending June 30, 1889, tells us that "the production of spat by aid of artificial methods has never been resorted to in this country, in consequence of the fact that the practical utility and economy of any proposed system has yet to be established." I should have thought that this matter could have been long since determined at the hatchery at Cold Spring Harbor, where, I have learned, such experiments have been successfully made. But, as the artificial propagation is not generally understood, and as it is extremely interesting, I shall briefly explain the most successful and general method employed in France: and I believe that the most obtuse reader will then see the feasibility of carrying on similar operations here.

The collection of the floating spat upon pieces of wood and stone is said to have been discovered by M. de Bon, Commissaire of Marine at St. Servan, France, in 1853; and we know that, when he announced his discovery, the matter was "at once taken up most enthusiastically by M. Coste," Professor of Embryology in the College of France. They undoubtedly drew public and scientific attention to this all-important branch of oyster culture; but I find that several years before the discovery of De Bon, the oystermen of the East River, New York, had not only made a similar discovery, but that they conceived the idea of utilizing it, and used *tiles* (a recent invention in French oyster culture) for collecting the spat, which they planted in the river and sound. Further, and in circumstantial proof of the statement, it is a fact that in 1855—the year when De Bon made his discovery—the Legislature of the State of New York enacted a law "to preserve to the private (oyster) farmers the fruits of their labor."

I am chiefly indebted to Mr. Bashford Dean's report on the Present Methods of Oyster Culture in France for the following brief description of the artificial propagation of the oyster in that country: The manner in which the spat or swimming oyster fry is obtained is very simple. Culturists place arched tiles, wooden trays, and other materials in the neighborhood of the natural

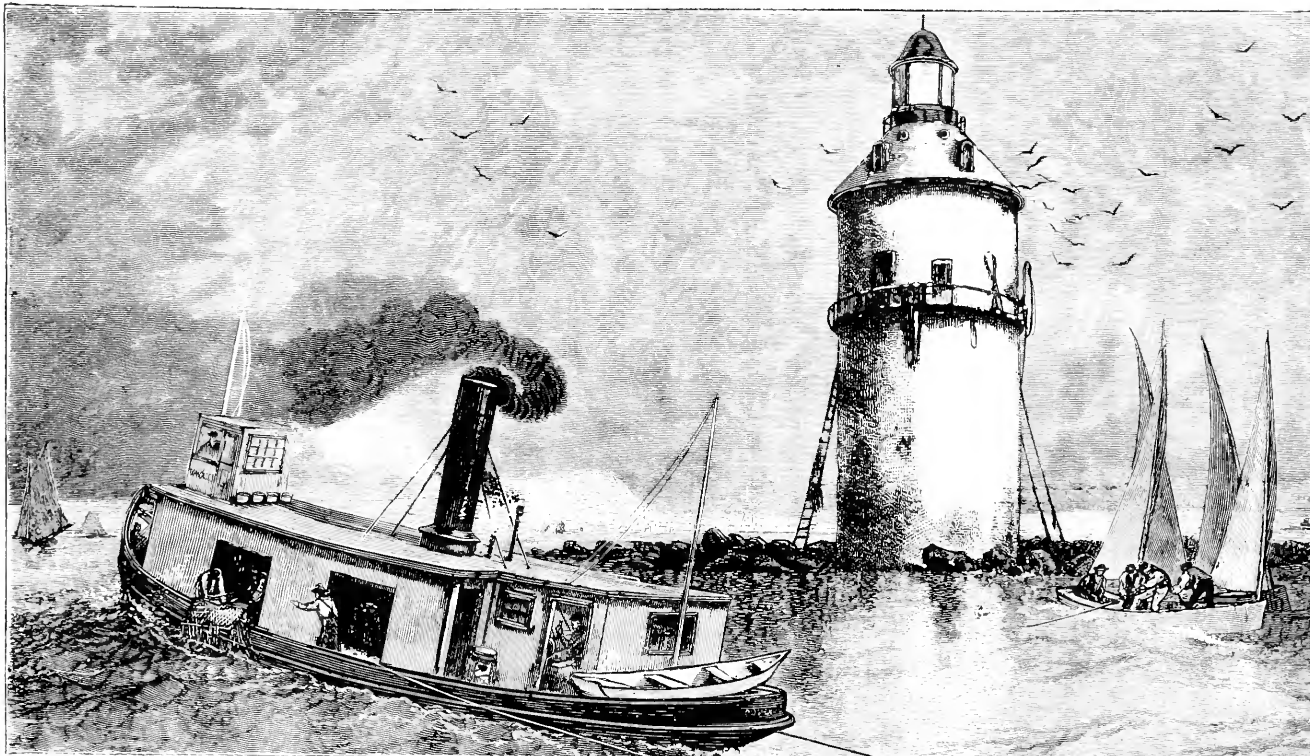

Fig. 6.—Oyster-Dredging in Long Island Sound.

banks about the 1st of July; the little spat at once cling to it, if they are anywhere near, and they are allowed to remain on

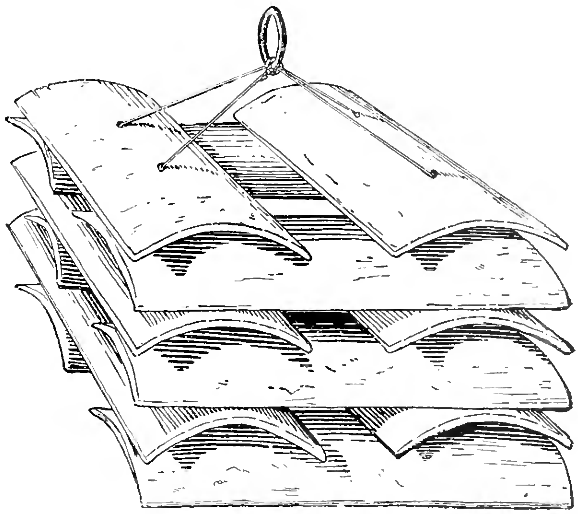

Fig. 7.—Tile Collectors.

the tile until October, when they have attained "about the size of a finger nail." The tiles are then carefully placed upon lighters and floated ashore, where the seedling oysters are detached from them "by short pushes of a chisel-like knife." The spat usually

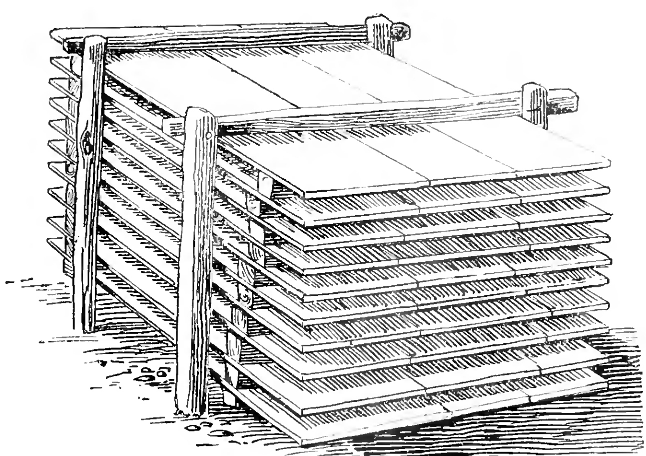

Fig. 8.—Wooden-Tray Collectors.

averages on moderately clean ground about four hundred per tile, but as many as two thousand have been counted on one tile of fourteen inches by six.

The seed oysters having been removed from the tile or wood "collectors," they are taken to the low-water line and arranged in flat wire-gauze rearing cases, which "lift from the bottom and prevent the young from being stifled by the shiftings of mud; it also renders the growth regular and rapid, and, above all, it protects the oysters from their enemies," the starfishes, drills, etc. "During the first few months rapid growth renders it necessary to pick out each fortnight and transfer to other cases the largest oysters." This is generally done by women, who at the same time take out the dead shells. And so the process goes on

FIG. 9.—WOODEN TRAYS IN POSITION ON MACADAMIZED BOTTOM.

until the oyster is sufficiently grown for table use, usually two to three years.

Sometimes the river banks or beaches selected for the oyster-developing cages are soft and muddy; and here again the French culturist teaches us a lesson. He is not deterred by the unsuitable bottom; he at once macadamizes it with sand and gravel, giving a crust that is clean and serves admirably for cultural purposes.

Another method for collecting spat is in enclosed ponds provided with spawning oysters. Flood gates prevent the escape of the water, which is kept at "an average depth of about four feet." The same style of "collectors" that are used in the open sea "parks" (as each individual's holding is called) are used in these

FIG. 10.—EXAMINING A TILE COVERED WITH OYSTER SPAT.

ponds; but the result in the latter seems to be much more satisfactory. The pond, having been macadamized, is first thoroughly dried "for two months, . . . doing away with all animal and plant

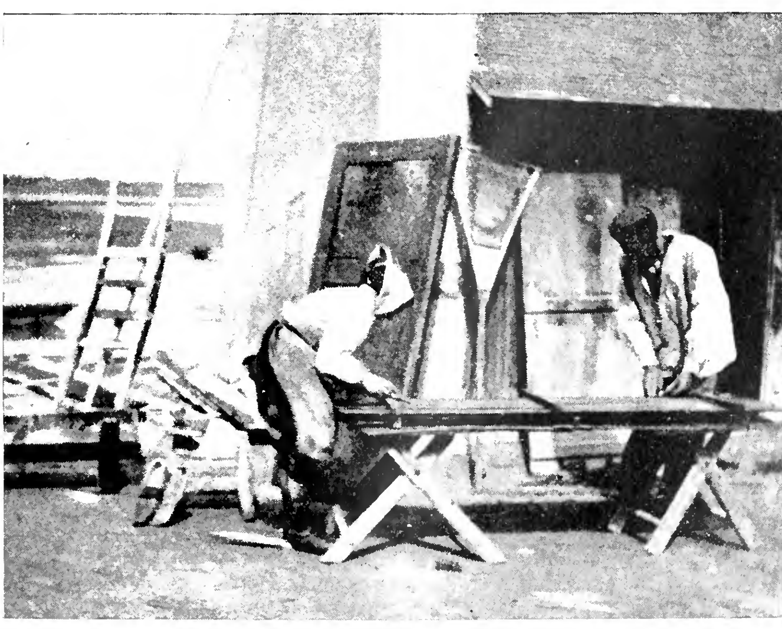

FIG. 11.—DISENGAGING SEED OYSTERS FROM A TRAY COLLECTOR.

life"; then the water is let in gradually from the sea until the required depth is obtained. For ordinary evaporation a small quantity of *fresh* water is allowed to be introduced, but sometimes it becomes necessary to admit tide water. There are hundreds of ponds along our coast that could be utilized in the same manner as the one which I have just described, and a little care to observe a proper density and temperature of the water, after the inclosure and macadamizing had been done, is all that would be necessary to secure quite as satisfactory results as have been obtained in France.

Stringent regulations governing the dredging of the French natural oyster beds have succeeded in rehabilitating the depleted

Fig. 12.—Cases for rearing Seed Oysters at Cancale, France.

banks at Granville, St. Malo, and Cancale; and it appears to me that similarly stringent State enactments in Maryland and Virginia would immensely benefit the productivity of the Chesapeake grounds. "Dredging within the prescribed limits (in France), as at Cancale, is granted so seldom that such occasions have become like holidays." The time allowed in 1890 was "between two and three hours." Mr. Dean thus describes this annual dredging expedition: "The beach is filled with spectators. At a cannon shot the little vessels start as in a regatta, each striving to be first on the ground. The dredges, four or five to a boat, are operated by half a dozen fishers. A cannon shot closes the dredging, and the little fleet returns shoreward, usually well laden."

Fig. 13.—Sorting the Growing Seed Oysters at Arcachon.

This scene is precisely similar to that which takes place at the opening and closing of the great sturgeon fishing of the Don Cossacks in southern Russia, which I described, in an article on Sturgeon Fishing on the Don, in 1890.

Fig. 14.—The Celebrated French Oyster Park at Breneguy.

To sum up, I think I have proved that State interference is necessary for the protection of the natural oyster beds on the Atlantic coast; that the artificial propagation of spat would materially assist in providing an abundant supply of food oysters; that private ownerships in certain plots of marginal waters should be induced by protective State legislation, thus encouraging oyster planters and cultivators to invest their time and money in the industry; and that, unless speedy measures are taken in these directions and for a more general "planting" of seed oysters, something akin to an oyster famine is not measurably far away.

EVOLUTION AND ETHICS.*

By Prof. THOMAS H. HUXLEY, F. R. S.

I.

Soleo enim et in aliena castra transire, non tanquam transfuga, sed tanquam explorator. (L. Annæi Senecæ Epist. II, 4.) [For you must know I sometimes make an excursion into the enemy's camp, not by way of deserter, but as a spy.]

THERE is a delightful child's story, known by the title of Jack and the Bean-stalk, with which my contemporaries who are present will be familiar. But so many of our grave and reverend juniors have been brought up on severer intellectual diet, and perhaps have become acquainted with fairyland only through primers of comparative mythology, that it may be needful to give an outline of the tale. It is a legend of a bean-plant, which grows and grows until it reaches the high heavens, and there spreads out into a vast canopy of foliage. The hero, being moved to climb the stalk, discovers that the leafy expanse supports a world, composed of the same elements as that below, but yet strangely new; and his adventures there, on which I may not dwell, must have completely changed his views of the nature of things, though the story, not having been composed by or for philosophers, has nothing to say about views.

My present enterprise has a certain analogy to that of the daring adventurer. I beg you to accompany me in an attempt to reach a world which, to many, is probably strange, by the help of a bean. It is, as you know, a simple, inert-looking thing. Yet, if planted under proper conditions, of which sufficient warmth is one of the most important, it manifests active powers of a very remarkable kind. A small green seedling emerges, rises to the

* The Romanes Lecture, delivered in the Sheldonian Theatre, Oxford, May 18, 1893. Reprinted by the kind permission of Macmillan & Co.

surface of the soil, rapidly increases in size, and at the same time undergoes a series of metamorphoses which do not excite our wonder as much as those which meet us in legendary history, merely because they are to be seen every day, and all day long.

By insensible steps the plant builds itself up into a large and various fabric of root, stem, leaves, flowers, and fruit, every one molded, within and without, in accordance with an extremely complex, but at the same time minutely defined, pattern. In each of these complicated structures, as in their smallest constituents, there is an immanent energy which, in harmony with that resident in all the others, incessantly works toward the maintenance of the whole and the efficient performance of the part which it has to play in the economy of Nature. But no sooner has the edifice, reared with such exact elaboration, attained completeness than it begins to crumble. By degrees the plant withers and disappears from view, leaving behind more or fewer apparently inert and simple bodies, just like the bean from which it sprang, and, like it, endowed with the potentiality of giving rise to a similar cycle of manifestations.

Neither the poetic nor the scientific imagination is put to much strain in the search after analogies with this process of going forth and, as it were, returning to the starting point. It may be likened to the ascent and descent of a slung stone, or to the course of an arrow along its trajectory. Or we may say that the living energy takes first an upward and then a downward road. Or it may seem preferable to compare the expansion of the germ into the full-grown plant to the unfolding of a fan, or to the rolling forth and widening of a stream, and thus arrive at the conception of "development," or "evolution." Here, as elsewhere, names are "noise and smoke"; the important point is to have a clear and adequate conception of the fact signified by a name. And in this case the fact is the Sisyphæan process, in the course of which the living and growing plant passes from the relative simplicity and latent potentiality of the seed to the full epiphany of a highly differentiated type, thence to fall back to simplicity and potentiality.

The value of a strong intellectual grasp of the nature of this process lies in the circumstance that what is true of the bean is true of living things in general. From very low forms up to the highest—in the animal no less than in the vegetable kingdom—the process of life presents the same appearance * of cyclical evo-

* I have been careful to speak of the "appearance" of cyclical evolution presented by living things; for, on critical examination, it will be found that the course of vegetable and of animal life is not exactly represented by the figure of a cycle which returns into itself. What actually happens, in all but the lowest organisms, is that one part of the growing

lution. Nay, we have but to cast our eyes over the rest of the world and cyclical change presents itself on all sides. It meets us in the water that flows to the sea and returns to the springs; in the heavenly bodies that wax and wane, go and return to their places; in the inexorable sequence of the ages of man's life; in that successive rise, apogee, and fall of dynasties and of states which is the most prominent topic of civil history.

As no man, fording a swift stream, can dip his foot twice into the same water, so no man can with exactness affirm of anything in the sensible world that it is.* As he utters the words, nay, as he thinks them, the predicate ceases to be applicable; the present

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germ (*A*) gives rise to tissues and organs; while another part (*B*) remains in its primitive condition, or is but slightly modified. The moiety *A* becomes the body of the adult and, sooner or later, perishes, while portions of the moiety *B* are detached and, as offspring, continue the life of the species. Thus, if we trace back an organism along the direct line of descent from its remotest ancestor, *B*, as a whole, has never suffered death; portions of it only have been cast off and died in each individual offspring.

Everybody is familiar with the way in which the "suckers" of a strawberry plant behave. A thin cylinder of living tissue keeps on growing at its free end, until it attains a considerable length. At successive intervals it develops buds, which grow into strawberry plants: and these become independent by the death of the parts of the sucker which connect them. The rest of the sucker, however, may go on living and growing indefinitely, and, circumstances remaining favorable, there is no obvious reason why it should ever die. The living substance *B* in a manner answers to the sucker. If we could restore the continuity which was once possessed by the portions of *B*, contained in all the individuals of a direct line of descent, they would form a sucker, or *stolon*, on which these individuals would be strung, and which would never have wholly died.

A species remains unchanged so long as the potentiality of development resident in *B* remains unaltered; so long, e. g., as the buds of the strawberry sucker tend to become typical strawberry plants. In the case of the progressive evolution of a species, the developmental potentiality of *B* becomes of a higher and higher order. In retrogressive evolution the contrary would be the case. The phenomena of atavism seem to show that retrogressive evolution—that is, the return of a species to one or other of its earlier forms—is a possibility to be reckoned with. The simplification of structure which is so common in the parasitic members of a group, however, does not properly come under this head. The wormlike, limbless *Lernæa* has no resemblance to any of the stages of development of the many-limbed active animals of the group to which it belongs.

* Heracleitus says "Ποταμῷ γὰρ οὐκ ἔστι δὶς ἐμβῆναι τῷ αὐτῷ"; but, to be strictly accurate, the river remains though the water of which it is composed changes—just as a man retains his identity though the whole substance of his body is constantly shifting.

This is put very well by Seneca (Ep. lviii, 20, Ed. Ruhkopf): "Corpora nostra rapiuntur fluminum more, quidquid vides currit cum tempore; nihil ex his quæ videmus manet. Ego ipse dum loquor mutari ista, mutatus sum. Hoc est quod ait Heraclitus 'In idem flumen bis non descendimus.' Manet idem fluminis nomen, aqua transmissa est. Hoc in amne manifestius est quam in homine, sed nos quoque non minus velox cursus prætervehit." [Our bodies are carried away as a river: all that you see runs down with time: nothing still remains the same: even while I say these things are changed, I am changed myself. This is what Heraclitus means, when he says, "We go not twice into the same river." The river still keeps its name but the water passeth away. This indeed is more manifest in a river than in man; but yet as swift a course carries us likewise away.—*Morell's translation.*]

has become the past; the "is" should be "was." And the more we learn of the nature of things, the more evident is it that what we call rest is only unperceived activity; that seeming peace is silent but strenuous battle. In every part, at every moment, the state of the cosmos is the expression of a transitory adjustment of contending forces; a scene of strife, in which all the combatants fall in turn. What is true of each part is true of the whole. Natural knowledge tends more and more to the conclusion that "all the choir of heaven and furniture of the earth" are the transitory forms of parcels of cosmic substance wending along the road of evolution, from nebulous potentiality, through endless growths of sun and planet and satellite; through all varieties of matter; through infinite diversities of life and thought; possibly through modes of being of which we neither have a conception, nor are competent to form any, back to the undefinable latency from which they arose. Thus the most obvious attribute of the cosmos is its impermanence. It assumes the aspect not so much of a permanent entity as of a changeful process, in which naught endures save the flow of energy and the rational order which pervades it.

We have climbed our bean-stalk and have reached a wonderland in which the common and the familiar become things new and strange. In the exploration of the cosmic process thus typified, the highest intelligence of man finds inexhaustible employment; giants are subdued to our service; and the spiritual affections of the contemplative philosopher are engaged by beauties worthy of eternal constancy.

But there is another aspect of the cosmic process, so perfect as a mechanism, so beautiful as a work of art. Where the cosmopoietic energy works through sentient beings, there arises, among its other manifestations, that which we call pain or suffering. This baleful product of evolution increases in quantity and in intensity, with advancing grades of animal organization, until it attains its highest level in man. Further, the consummation is not reached in man, the mere animal; nor in man, the whole or half savage; but only in man, the member of an organized polity. And it is a necessary consequence of his attempt to live in this way; that is, under those conditions which are essential to the full development of his noblest powers.

Man, the animal, in fact, has worked his way to the headship of the sentient world, and has become the superb animal which he is, in virtue of his success in the struggle for existence. The conditions having been of a certain order, man's organization has adjusted itself to them better than that of his competitors in the cosmic strife. In the case of mankind, the self-assertion, the unscrupulous seizing upon all that can be grasped, the tenacious

holding of all that can be kept, which constitute the essence of the struggle for existence, have answered. For his successful progress, as far as the savage state, man has been largely indebted to those qualities which he shares with the ape and the tiger: his exceptional physical organization; his cunning, his sociability, his curiosity and his imitativeness; his ruthless and ferocious destructiveness when his anger is roused by opposition.

But, in proportion as men have passed from anarchy to social organization and in proportion as civilization has grown in worth, these deeply ingrained serviceable qualities have become defects. After the manner of successful persons, civilized man would gladly kick down the ladder by which he has climbed. He would be only too pleased to see "the ape and the tiger die." But they decline to suit his convenience; and the unwelcome intrusion of these boon companions of his hot youth into the ranged existence of civil life adds pains and griefs, innumerable and immeasurably great, to those which the cosmic process necessarily brings on the mere animal. In fact, civilized man brands all these ape and tiger promptings with the name of sins; he punishes many of the acts which flow from them as crimes; and, in extreme cases, he does his best to put an end to the survival of the fittest of former days by axe and rope.

I have said that civilized man has reached this point; the assertion is perhaps too broad and general; I had better put it that ethical man has attained thereto. The science of ethics professes to furnish us with a reasoned rule of life; to tell us what is right action and why it is so. Whatever difference of opinion may exist among experts, there is a general consensus that the ape and tiger methods of the struggle for existence are not reconcilable with sound ethical principles.

The hero of our story descended the bean-stalk, and came back to the common world, where fare and work were alike hard; where ugly competitors were much commoner than beautiful princesses; and where the everlasting battle with self was much less sure to be crowned with victory than a turn-to with a giant. We have done the like. Thousands upon thousands of our fellows, thousands of years ago, have preceded us in finding themselves face to face with the same dread problem of evil. They also have seen that the cosmic process is evolution; that it is full of wonder, full of beauty, and, at the same time, full of pain. They have sought to discover the bearing of these great facts on ethics; to find out whether there is, or is not, a sanction for morality in the ways of the cosmos.

Theories of the universe, in which the conception of evolution plays a leading part, were extant at least six centuries before our

era. Certain knowledge of them, in the fifth century, reaches us from localities as distant as the valley of the Ganges and the Asiatic coasts of the Ægean. To the early philosophers of Hindustan, no less than to those of Ionia, the salient and characteristic feature of the phenomenal world was its changefulness; the unresting flow of all things, through birth to visible being and thence to not being, in which they could discern no sign of a beginning and for which they saw no prospect of an ending. It was no less plain to some of these antique forerunners of modern philosophy that suffering is the badge of all the tribe of sentient things; that it is no accidental accompaniment, but an essential constituent of the cosmic process. The energetic Greek might find fierce joys in a world in which "strife is father and king"; but the old Aryan spirit was subdued to quietism in the Indian sage; the mist of suffering which spread over humanity hid everything else from his view; to him life was one with suffering and suffering with life.

In Hindustan, as in Ionia, a period of relatively high and tolerably stable civilization had succeeded long ages of semi-barbarism and struggle. Out of wealth and security had come leisure and refinement, and, close at their heels, had followed the malady of thought. To the struggle for bare existence, which never ends, though it may be alleviated and partially disguised for a fortunate few, succeeded the struggle to make existence intelligible and to bring the order of things into harmony with the moral sense of man, which also never ends, but, for the thinking few, becomes keener with every increase of knowledge and with every step toward the realization of a worthy ideal of life.

Two thousand five hundred years ago, the value of civilization was as apparent as it is now; then, as now, it was obvious that only in the garden of an orderly polity can the finest fruits humanity is capable of bearing be produced. But it had also become evident that the blessings of culture were not unmixed. The garden was apt to turn into a hothouse. The stimulation of the senses, the pampering of the emotions, endlessly multiplied the sources of pleasure. The constant widening of the intellectual field indefinitely extended the range of that especially human faculty of looking before and after, which adds to the fleeting present those old and new worlds of the past and the future, wherein men dwell the more the higher their culture. But that very sharpening of the sense and that subtle refinement of emotion which brought such a wealth of pleasures, were fatally attended by a proportional enlargement of the capacity for suffering; and the divine faculty of imagination, while it created new heavens and new earths, provided them with the corresponding hells of futile regret for the past and morbid anxiety for the

future.* Finally, the inevitable penalty of overstimulation, exhaustion, opened the gates of civilization to its great enemy, *ennui*: the stale and flat weariness when man delights not, nor woman neither—when all things are vanity and vexation, and life seems not worth living except to escape the bore of dying.

Even purely intellectual progress brings about its revenges. Problems settled in a rough-and-ready way by rude men, absorbed in action, demand renewed attention and show themselves to be still unread riddles when men have time to think. The beneficent demon, doubt, whose name is Legion and who dwells among the tombs of old faiths, enters into mankind and thenceforth refuses to be cast out. Sacred customs, venerable dooms of ancestral wisdom, hallowed by tradition and professing to hold good for all time, are put to the question. Cultured reflection asks for their credentials; judges them by its own standards; finally, gathers those of which it approves into ethical systems, in which the reasoning is rarely much more than a decent pretext for the adoption of foregone conclusions.

One of the oldest and most important elements in such systems is the conception of justice. Society is impossible unless those who are associated agree to observe certain rules of conduct toward one another; its stability depends on the steadiness with which they abide by that agreement; and, so far as they waver, that mutual trust which is the bond of society is weakened or destroyed. Wolves could not hunt in packs except for the real, though unexpressed, understanding that they should not attack one another during the chase. The most rudimentary polity is a pack of men living under the like tacit, or expressed, understanding; and having made the very important advance upon wolf society, that they agree to use the force of the whole body against individuals who violate it and in favor of those who observe it. This observance of a common understanding, with the consequent distribution of punishments and rewards according to accepted rules, received the name of justice, while the contrary was called injustice. Early ethics did not take much note of the animus of the violator of the rules. But civilization could not advance far

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* "Multa bona nostra nobis nocent, timoris enim tormentum memoria reducit, providentia anticipat. Nemo tantum praesentibus miser est." (Seneca, Ep. v, 7.) [Thus many things, really good in themselves, hurt us: for memory recalls and forecast anticipates the torment of fear. No one is wretched from what is present only.—*Morell's translation.*]

Among the many wise and weighty aphorisms of the Roman Bacon, few sound the realities of life more deeply than "Multa bona nostra nobis nocent." If there is a soul of good in things evil, it is at least equally true that there is a soul of evil in things good: for things, like men, have "les défauts de leurs qualités." It is one of the last lessons one learns from experience, but not the least important, that a heavy tax is levied upon all forms of success, and that failure is one of the commonest disguises assumed by blessings.

without the establishment of a capital distinction between the case of involuntary and that of willful misdeed—between a merely wrong action and a guilty one. And, with increasing refinement of moral appreciation, the problem of desert, which arises out of this distinction, acquired more and more theoretical and practical importance. If life must be given for life, yet it was recognized that the unintentional slayer did not altogether deserve death; and, by a sort of compromise between the public and the private conception of justice, a sanctuary was provided in which he might take refuge from the avenger of blood.

The idea of justice thus underwent a gradual sublimation from punishment and reward according to acts, to punishment and reward according to desert; or, in other words, according to motive. Righteousness—that is, action from right motive—not only became synonymous with justice, but the positive constituent of innocence and the very heart of goodness.

Now when the ancient sage, whether Indian or Greek, who had attained to this conception of goodness, looked the world, and especially human life, in the face, he found it as hard as we do to bring the course of evolution into harmony with even the elementary requirements of the ethical ideal of the just and the good.

If there is one thing plainer than another, it is that neither the pleasures nor the pains of life in the merely animal world are distributed according to desert, for it is admittedly impossible for the lower orders of sentient beings to deserve either the one or the other. If there is a generalization from the facts of human life, which has the assent of thoughtful men in every age and country, it is that the violator of ethical rules constantly escapes the punishment which he deserves; that the wicked flourishes like a green bay tree, while the righteous begs his bread; that the sins of the fathers are visited upon the children; that in the realm of Nature ignorance is punished just as severely as willful wrong; and that thousands upon thousands of innocent beings suffer for the crime or the unintentional trespass of one.

Greek and Semite and Indian are agreed upon this subject. The book of Job is at one with the "Works and Days" and the Buddhist Sutras; the Psalmist and the Preacher of Israel with the tragic poets of Greece. What is a more common motive of the ancient tragedy, in fact, than the unfathomable injustice of the nature of things? What is more deeply felt to be true than its presentation of the destruction of the blameless by the work of his own hands, or by the fatal operation of the sins of others? Surely Œdipus was pure of heart; it was the natural sequence of events—the cosmic process—which drove him, in all innocence,

to slay his father and become the husband of his mother, to the desolation of his people and his own headlong ruin. Or, to step for a moment beyond the chronological limits I have set myself, what constitutes the sempiternal attraction of Hamlet but the appeal to deepest experience of that history of a no less blameless dreamer, dragged, in spite of himself, into a world out of joint; involved in a tangle of crime and misery, created by one of the prime agents of the cosmic process as it works in and through man?

Thus, brought before the tribunal of ethics, the cosmos might well seem to stand condemned. The conscience of man revolted against the moral indifference of Nature and the microcosmic atoms hould have found the illimitable macrocosm guilty. But few, or none, ventured to record that verdict.

In the great Semitic trial of this issue, Job takes refuge in silence and submission; the Indian and the Greek, less wise perhaps, attempt to reconcile the irreconcilable and plead for the defendant. To this end, the Greeks invented Theodicies; while the Indians devised what, in its ultimate form, must rather be termed a Cosmodicy. For, though Buddhism recognizes gods many and lords many, they are products of the cosmic process; and transitory, however long enduring, manifestations of its eternal activity. In the doctrine of transmigration, whatever its origin, Brahmanical and Buddhist speculation found, ready to hand,* the

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* "There is within the body of every man a soul which, at the death of the body, flies away from it like a bird out of a cage, and enters upon a new life . . . either in one of the heavens or one of the hells or on this earth. The only exception is the rare case of a man having in this life acquired a true knowledge of God. According to the pre-Buddhistic theory, the soul of such a man goes along the path of the Gods to God and, being united with him, enters upon an immortal life in which his individuality is not extinguished. In the later theory, his soul is directly absorbed into the Great Soul, is lost in it and has no longer any independent existence. The souls of all other men enter, after the death of the body, upon a new existence in one or other of the many different modes of being. If in heaven or hell, the soul itself becomes a god or demon without entering a body; all superhuman beings save the great gods being looked upon as not eternal, but merely temporary creatures. If the soul returns to earth it may or may not enter a new body; and this either of a human being, an animal, a plant, or even a material object. For all these are possessed of souls, and there is no essential difference between these souls and the souls of men—all being alike mere sparks of the Great Spirit, who is the only real existence." (Rhys Davids, Hibbert Lectures, 1881, p. 83.)

For what I have said about Indian philosophy, I am particularly indebted to the luminous exposition of primitive Buddhism and its relations to earlier Hindu thought, which is given by Prof. Rhys Davids in his remarkable Hibbert Lectures for 1881, and Buddhism," (1890). The only apology I can offer for the freedom with which I have borrowed from him in these notes, is my desire to leave no doubt as to my indebtedness. I have also found Dr. Oldenberg's Buddha (Ed. 2, 1890) very helpful. The origin of the theory of transmigration stated in the above extract is an unsolved problem. That it differs widely from the Egyptian metempsychosis is clear. In fact, since men usually people the other

means of constructing a plausible vindication of the ways of the cosmos to man. If this world is full of pain and sorrow; if grief and evil fall, like the rain, upon both the just and the unjust; it is because, like the rain, they are links in the endless chain of natural causation by which past, present, and future are indissolubly connected; and there is no more injustice in the one case than in the other. Every sentient being is reaping as it has sown; if not in this life, then in one or other of the infinite series of antecedent existences of which it is the latest term. The present distribution of good and evil is, therefore, the algebraical sum of accumulated positive and negative deserts; or rather, it depends on the floating balance of the account. For it was not thought necessary that a complete settlement should ever take place. Arrears might stand over as a sort of "hanging gale"; a period of celestial happiness just earned might be succeeded by ages of torment in a hideous nether world, the balance still overdue for some remote ancestral error.*

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worlds with phantoms of this, the Egyptian doctrine would seem to presuppose the Indian as a more archaic belief.

Prof. Rhys Davids has fully insisted upon the ethical importance of the transmigration theory. "One of the latest speculations now being put forward among ourselves would seek to explain each man's character, and even his outward condition in life, by the character he inherited from his ancestors, a character gradually formed during a practically endless series of past existences, modified only by the conditions into which he was born, those very conditions being also, in like manner, the last result of a practically endless series of past causes. Gotama's speculation might be stated in the same words. But it attempted also to explain, in a way different from that which would be adopted by the exponents of the modern theory, that strange problem which it is also the motive of the wonderful drama of the book of Job to explain—the fact that the actual distribution here of good fortune, or misery, is entirely independent of the moral qualities which men call good or bad. We can not wonder that a teacher, whose whole system was so essentially an ethical reformation, should have felt it incumbent upon him to seek an explanation of this apparent injustice. And all the more so, since the belief he had inherited, the theory of the transmigration of souls, had provided a solution perfectly sufficient to any one who could accept that belief." (Hibbert Lectures, p. 93.) I should venture to suggest the substitution of "largely" for "entirely" in the foregoing passage. Whether a ship makes a good or a bad voyage is largely independent of the conduct of the captain, but it is as largely affected by that conduct. Though powerless before a hurricane, he may weather many a bad gale.

* "The outward condition of the soul is, in each new birth, determined by its actions in a previous birth; but by each action in succession and not by the balance struck after the evil has been reckoned off against the good. A good man, who has once uttered a slander, may spend a hundred thousand years as a god, in consequence of his goodness, and, when the power of his good actions is exhausted, may be born as a dumb man on account of his transgression; and a robber who has once done an act of mercy, may come to life in a king's body as a result of his virtue, and then suffer torments for ages in hell or as a ghost without a body, or be reborn many times as a slave or an outcast, in consequence of his evil life.

"There is no escape, according to this theory, from the result of any act; though it is only the consequences of its own acts that each soul has to endure. The force has been set in motion by itself and can never stop; and its effect can never be foretold. If evil, it can

Whether the cosmic process looks any more moral than at first, after such a vindication, may perhaps be questioned. Yet this plea of justification is not less plausible than others; and none but very hasty thinkers will reject it on the ground of inherent absurdity. Like the doctrine of evolution itself, that of transmigration has its roots in the world of reality; and it may claim such support as the great argument from analogy is capable of supplying.

Every-day experience familiarizes us with the facts which are grouped under the name of heredity. Every one of us bears upon him obvious marks of his parentage, perhaps of remoter relationships. More particularly, the sum of tendencies to act in a certain way, which we call "character," is often to be traced through a long series of progenitors and collaterals. So we may justly say that this "character"—this moral and intellectual essence of a man—does veritably pass over from one fleshly tabernacle to another and does really transmigrate from generation to generation. In the newborn infant, the character of the stock lies latent and the Ego is little more than a bundle of potentialities. But, very early, these become actualities; from childhood to age they manifest themselves in dullness or brightness, weakness or strength, viciousness or uprightness; and with each feature modified by confluence with another character, if by nothing else, the character passes on to its incarnation in new bodies.

The Indian philosophers called character, as thus defined, "karma." * It is this karma which passed from life to life and

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never be modified or prevented, for it depends on a cause already completed, that is now forever beyond the soul's control. There is even no continuing consciousness, no memory of the past that could guide the soul to any knowledge of its fate. The only advantage open to it is to add in this life to the sum of its good actions, that it may bear fruit with the rest. And even this can only happen in some future life under essentially the same conditions as the present one; subject, like the present one, to old age, decay, and death; and affording opportunity, like the present one, for the commission of errors, ignorances, or sins, which in their turn must inevitably produce their due effect of sickness, disability, or woe. Thus is the soul tossed about from life to life, from billow to billow, in the great ocean of transmigration. And there is no escape save for the very few who, during their birth as men, attain to a right knowledge of the Great Spirit: and thus enter into immortality, or, as the later philosophers taught, are absorbed into the Divine Essence." (Rhys Davids, Hibbert Lectures, pp. 85, 86.)

The state after death, thus imagined by the Hindu philosophers, has a certain analogy to the purgatory of the Roman Church; except that escape from it is dependent not on a divine decree modified, it may be, by sacerdotal or saintly intercession, but by the acts of the individual himself; and that while ultimate emergence into heavenly bliss of the good, or well-prayed for, Catholic is professedly assurred, the chances in favor of the attainment of absorption, or of Nirvana, by any individual Hindu are extremely small.

* "That part of the then prevalent transmigration theory which could not be proved false seemed to meet a deeply felt necessity, seemed to supply a moral cause which would explain the unequal distribution here of happiness or woe, so utterly inconsistent with the

linked them in the chain of transmigrations; and they held that it is modified in each life, not merely by confluence of parentage, but by its own acts. They were, in fact, strong believers in the theory, so much disputed just at present, of the hereditary transmission of acquired characters. That the manifestation of the tendencies of a character may be greatly facilitated, or impeded, by conditions, of which self-discipline, or the absence of it, are among the most important, is indubitable; but that the character itself is modified in this way is by no means so certain; it is not so sure that the transmitted character of an evil liver is worse, or that of a righteous man better, than that which he received. Indian philosophy, however, did not admit of any doubt on this subject; the belief in the influence of conditions, notably of self-discipline, on the karma was not merely a necessary postulate of its theory of retribution, but it presented the only way of escape from the endless round of transmigrations.

The earlier forms of Indian philosophy agreed with those prevalent in our own times, in supposing the existence of a permanent reality, or "substance," beneath the shifting series of phenomena, whether of matter or of mind. The substance of the cosmos was "Brahma," that of the individual man "Atman"; and the latter was separated from the former only, if I may so speak, by its phenomenal envelope, by the casing of sensations, thoughts and desires, pleasures and pains, which make up the illusive phantasmagoria of life. This the ignorant take for reality; their "Atman" therefore remains eternally imprisoned in delusions, bound by the fetters of desire and scourged by the whip of misery. But the man who has attained enlightenment sees that the apparent reality is mere illusion, or, as was said a couple

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present characters of men." Gautama "still therefore talked of men's previous existence, but by no means in the way that he is generally represented to have done." What he taught was "the transmigration of character." "Gotama held that after the death of any being, whether human or not, there survived nothing at all but that being's 'Karma,' the result, that is, of its mental and bodily actions. Every individual, whether human or divine, was the last inheritor and the last result of the Karma of a long series of past individuals—a series so long that its beginning is beyond the reach of calculation, and its end will be coincident with the destruction of the world." (Rhys Davids, Hibbert Lectures, p. 92.)

In the theory of evolution, the tendency of a germ to develop according to a certain specific type, e. g., of the kidney-bean seed to grow into a plant having all the characters of *Phaseolus vulgaris*, is its "Karma." It is the "last inheritor and the last result" of all the conditions that have affected a line of ancestry which goes back for many millions of years to the time when life first appeared on the earth. The moiety B of the substance of the bean plant (see note, p. 20), is the last link in a once continuous chain extending from the primitive living substance; and the characters of the successive species to which it has given rise are the manifestations of its gradually modified Karma. As Prof. Rhys Davids aptly says, the snowdrop "is a snowdrop and not an oak, and just that kind of snowdrop, because it is the outcome of the Karma of an endless series of past existences." (Hibbert Lectures, p. 114.)

of thousand years later, that there is nothing good nor bad but thinking makes it so. If the cosmos "is just and of our pleasant vices makes instruments to scourge us," it would seem that the only way to escape from our heritage of evil is to destroy that fountain of desire whence our vices flow; to refuse any longer to be the instruments of the evolutionary process and withdraw from the struggle for existence. If the karma is modifiable by self-discipline, if its coarser desires, one after another, can be extinguished, the ultimate fundamental desire of self-assertion, or the desire to be, may also be destroyed.* Then the bubble of illusion will burst, and the freed individual "Atman" will lose itself in the universal "Brahma."

Such seems to have been the pre-Buddhistic conception of salvation and of the way to be followed by those who would attain thereto. No more thorough mortification of the flesh has ever been attempted than that achieved by the Indian ascetic anchorite; no later monachism has so nearly succeeded in reducing the human mind to that condition of impassive *quasi*-somnambulism which, but for its acknowledged holiness, might run the risk of being confounded with idiocy.

And this salvation, it will be observed, was to be attained through knowledge, and by action based on that knowledge; just as the experimenter, who would obtain a certain physical or chemical result, must have a knowledge of the natural laws involved and the persistent disciplined will adequate to carry out all the various operations required. The supernatural, in our sense of the term, was entirely excluded. There was no external power which could affect the sequence of cause and effect which gives rise to karma; none but the will of the subject of the karma which could put an end to it.

Only one rule of conduct could be based upon the remarkable theory of which I have endeavored to give a reasoned outline. It

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* "It is interesting to notice that the very point which is the weakness of the theory—the supposed concentration of the effect of the Karma in one new being—presented itself to the early Buddhists themselves as a difficulty. They avoided it, partly by explaining that it was a particular thirst in the creature dying (a craving, Tanhā, which plays otherwise a great part in the Buddhist theory) which actually caused the birth of the new individual who was to inherit the Karma of the former one. But, how this took place, how the craving desire produced this effect, was acknowledged to be a mystery patent only to Buddha." (Rhys Davids, Hibbert Lectures, p. 95.)

Among the many parallelisms of Stoicism and Buddhism, it is curious to find one for this Tanhā, "thirst," or "craving desire" for life. Seneca writes (Epist. lxxvi, 18): "Si enim ullum aliud est bonum quam honestum, sequetur nos *aviditas vitæ* aviditas rerum vitam instruentium: quod est intolerabile infinitum, vagum." [Besides, was there any other good than what is right and fit, we should be persecuted with the desire of life, and an insatiable hankering after all the requisites thereto, which is intolerable, infinite, vague. —*Morell's translation.*]

was folly to continue to exist when an overplus of pain was certain, and the probabilities in favor of the increase of misery with the prolongation of existence were so overwhelming. Slaying the body only made matters worse; there was nothing for it but to slay the soul by the voluntary arrest of all its activities. Property, social ties, family affections, common companionship, must be abandoned; the most natural appetites, even that for food, must be suppressed, or at least minimized; until all that remained of a man was the impassive, extenuated, mendicant monk, self-hypnotized into cataleptic trances, which the deluded mystic took for foretastes of the final union with Brahma.

The founder of Buddhism accepted the chief postulates demanded by his predecessors. But he was not satisfied with the practical annihilation involved in merging the individual existence in the unconditioned—the Atman in Brahma. It would seem that the admission of the existence of any substance whatever—even of the tenuity of that which has neither quality nor energy and of which no predicate whatever can be asserted—appeared to him to be a danger and a snare. Though reduced to a hypostatized negation, Brahma was not to be trusted; so long as entity was there, it might conceivably resume the weary round of evolution, with all its train of immeasurable miseries. Gautama got rid of even that shade of a shadow of permanent existence by a metaphysical *tour de force* of great interest to the student of philosophy, seeing that it supplies the wanting half of Bishop Berkeley's well-known idealistic argument.

Granting the premises, I am not aware of any escape from Berkeley's conclusion, that the "substance" of matter is a metaphysical unknown quantity, of the existence of which there is no proof. What Berkeley does not seem to have so clearly perceived is that the non-existence of a substance of mind is equally arguable; and that the result of the impartial application of his reasonings is the reduction of the All to coexistences and sequences of phenomena, beneath and beyond which there is nothing cognoscible. It is a remarkable indication of the subtlety of Indian speculation that Gautama should have seen deeper than the greatest of modern idealists; though it must be admitted that, if some of Berkeley's reasonings respecting the nature of spirit are pushed home, they reach pretty much the same conclusion.*

* "The distinguishing characteristic of Buddhism was that it started a new line, that it looked upon the deepest questions men have to solve from an entirely different standpoint. It swept away from the field of its vision the whole of the great soul-theory which had hitherto so completely filled and dominated the minds of the superstitious and the thoughtful alike. For the first time in the history of the world, it proclaimed a salvation which each man could gain for himself and by himself, in this world, during this life, without any the least reference to God, or to gods, either great or small. Like the Upanishads, it placed

Accepting the prevalent Brahmanical doctrine that the whole cosmos, celestial, terrestrial, and infernal, with its population of gods and other celestial beings, of sentient animals, of Mara and his devils, is incessantly shifting through recurring cycles of pro-

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the first importance on knowledge; but it was no longer a knowledge of God, it was a clear perception of the real nature, as they supposed it to be, of men and things. And it added to the necessity of knowledge, the necessity of purity, of courtesy, of uprightness, of peace, and of a universal love far reaching, grown great and beyond measure." (Rhys Davids, Hibbert Lectures, p. 29.)

The contemporary Greek philosophy takes an analogous direction. According to Heracleitus, the universe was made neither by gods nor men; but, from all eternity has been, and to all eternity will be, immortal fire, glowing and fading in due measure. (Mullach, Heracliti Fragmenta, 27.) And the part assigned by his successors the Stoics, to the knowledge and the volition of the "wise man" made their Divinity (for logical thinkers) a subject for compliments, rather than a power to be reckoned with. In Hindu speculation the "Arahat," still more the "Buddha," becomes the superior of Brahma: the stoical "wise man" is, at least, the equal of Zeus.

Berkeley affirms over and over again that no idea can be formed of a soul or spirit: "If any man shall doubt of the truth of what is here delivered, let him but reflect and try if he can form any idea of power or active being; and whether he hath ideas of two principal powers marked by the names of *will* and *understanding* distinct from each other, as well as from a third idea of substance or being in general, with a relative notion of its supporting or being the subject of the aforesaid power, which is signified by the name *soul* or *spirit*. This is what some hold: but, so far as I can see, the words *will*, *soul*, *spirit*, do not stand for different ideas, or in truth for any idea at all, but for something which is very different from ideas, and which, being an agent, can not be like unto or represented by any idea whatever [though it must be owned at the same time, that we have some notion of soul, spirit, and the operations of the mind, such as willing, loving, hating, inasmuch as we know or understand the meaning of these words"]. (The Principles of Human Knowledge, lxxvi. See also §§ lxxxix, cxxxv, cxlv.)

It is open to discussion, I think, whether it is possible to have "some notion" of that of which we can form no "idea."

Berkeley attaches several predicates to the "perceiving active being mind, spirit, soul, or myself" (Part I, II). It is said, for example, to be "indivisible, incorporeal, unextended, and incorruptible." The predicate indivisible, though negative in form, has highly positive consequences. For, if "perceiving active being" is strictly indivisible, man's soul must be one with the Divine spirit; which is good Hindu or Stoical doctrine, but hardly orthodox Christian philosophy. If, on the other hand, the "substance" of active perceiving "being" is actually divided into the one Divine and innumerable human entities, how can the predicate "indivisible" be rigorously applicable to it?

Taking the words cited, as they stand, they amount to the denial of the possibility of any knowledge of substance. "Matter" having been resolved into mere affections of "spirit," "spirit" melts away into an admittedly inconceivable and unknowable hypostasis of thought and power—consequently the existence of anything in the universe beyond a flow of phenomena is a purely hypothetical assumption. Indeed, a pyrrhonist might raise the objection that if "esse" is "percipi" spirit itself can have no existence except as a perception, hypostatized into a "self" or as a perception of some other spirit. In the former case, objective reality vanishes; in the latter, there would seem to be the need of an infinite series of spirits each perceiving the others.

It is curious to observe how very closely the phraseology of Berkeley sometimes approaches that of the Stoics: thus (cxlviii): "It seems to be a *general pretense of the unthinking* herd that *they can not see God*. . . . But, alas! we need only open our eyes to see

duction and destruction, in each of which every human being has his transmigratory representative, Gautama proceeded to eliminate substance altogether; and to reduce the cosmos to a mere flow of sensations, emotions, volitions, and thoughts, devoid of any substratum. As on the surface of a stream of water we see

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the Sovereign Lord of all things with a more full and clear view than we do any of our fellow-creatures; . . . we do at all times and in all places perceive manifest tokens of the Divinity: everything we see, hear, feel, or any wise perceive by sense, being a sign or effect of the power of God." . . . cxlix. "It is therefore plain, that *nothing can be more evident* to any one that is capable of the least reflection, *than the existence of God*, or a spirit who is intimately present to our minds producing in them all that variety of ideas or sensations, which continually affect us, on whom we have an absolute and entire dependence, in short, *in whom we live and move and have our being*." cl. "[But you will say hath Nature no share in the production of natural things and must they be all ascribed to the immediate and sole operation of God? . . . if by *Nature* is meant some being distinct from God, as well as from the laws of Nature and things perceived by sense, I must confess that word is to me an empty sound, without any intelligent meaning annexed to it.] Nature in this acceptation is a vain *Chimæra* introduced by those heathens who had not just notions of the omnipresence and infinite perfection of God."

(Compare Seneca, De Beneficiis, iv, 7.)

"Natura, inquit, hæc mihi præstat. Non intelligis te, quum hoc dicis, mutare Nomen Deo? Quid enim est aliud Natura, quam Deus, et divina ratio, toti mundo et partibus ejus inserta? Quoties voles, tibi licet aliter hunc auctorem rerum nostrarum compellare, et Jovem illum optimum et maximum rite dices, et tonantem, et statorem: qui non, ut historici tradiderunt, ex eo quod post votum susceptum acies Romanorum fugientum stetit, sed quod stant beneficio ejus omnia, stator, stabilitorque est: hunc eundem et fatum si dixeris, non mentieris, nam quum fatum nihil aliud est, quam series implexa causarum, ille est prima omnium causa, ea qua cæteræ pendent." ["Nature," says my opponent, "gives me all this." Do you not perceive when you say this that you merely speak of God under another name, for what is Nature but God and divine reason, which pervades the universe and all its parts? You may address the author of our world by as many different titles as you please; you may rightly call him Jupiter, Best and Greatest, and the Thunderer, or the Stayer, so called, not because, as the historians tell us, he stayed the flight of the Roman army in answer to the prayer of Romulus, but because all things continue in their stay through his goodness. If you were to call this same personage Fate, you would not lie; for since fate is nothing more than a connected chain of causes, he is the first cause of all, upon which all the rest depend.—*Bohn's translation.*]

It would appear, therefore, that the good bishop is somewhat hard upon the "heathen," of whose words his own might be a paraphrase.

There is yet another direction in which Berkeley's philosophy, I will not say agrees with Gautama's, but at any rate helps to make a fundamental dogma of Buddhism intelligible.

"I find I can excite ideas in my mind at pleasure, and vary and shift the scene as often as I think fit. It is no more than willing, and straightway this or that idea arises in my fancy: and by the same power, it is obliterated, and makes way for another. This making and unmaking of ideas doth very properly denominate the mind active. Thus much is certain and grounded on experience. . . ." (Principles, xxviii.)

A good many of us, I fancy, have reason to think that experience tells them very much the contrary; and are painfully familiar with the obsession of the mind by ideas which can not be obliterated by any effort of the will and steadily refuse to make way for any others. But what I desire to point out is that if Gautama was equally confident that he could "make and unmake" ideas—then, since he had resolved self into a group of ideal phantoms—the possibility of abolishing self by volition naturally followed.

ripples and whirlpools, which last for a while and then vanish with the causes that gave rise to them, so what seem individual existences are mere temporary associations of phenomena circling round a center, "like a dog tied to a post." In the whole universe there is nothing permanent, no eternal substance either of mind or of matter. Personality is a metaphysical fancy; and, in very truth, not only we, but all things, in the worlds without end of the cosmic phantasmagoria, are such stuff as dreams are made of.

What then becomes of karma? Karma remains untouched. As the peculiar form of energy we call magnetism may be transmitted from a loadstone to a piece of steel, from the steel to a piece of nickel, as it may be strengthened or weakened by the conditions to which it is subjected while resident in each piece, so it seems to have been conceived that karma might be transmitted from one phenomenal association to another by a sort of induction. However this may be, Gautama doubtless had a better guarantee for the abolition of transmigration, when no wrack of substance, either of Atman or of Brahma, was left behind; when, in short, a man had but to dream that he willed not to dream, to put an end to all dreaming.

This end of life's dream is Nirvana. What Nirvana is the learned do not agree. But, since the best original authorities tell us there is neither desire, nor activity, nor any possibility of phenomenal reappearance for the sage who has entered Nirvana, it may be safely said of this acme of Buddhistic philosophy—the rest is silence.*

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* According to Buddhism, the relation of one life to the next is merely that borne by the flame of one lamp to the flame of another lamp which is set alight by it. To the "Arahat" or adept "no outward form, no compound thing, no creature, no creator, no existence of any kind, must appear to be other than a temporary collocation of its component parts fated inevitably to be dissolved." (Rhys Davids, Hibbert Lectures, p. 211.)

The self is nothing but a group of phenomena held together by the desire of life; when that desire shall have ceased "the Karma of that particular chain of lives will cease to influence any longer any distinct individual, and there will be no more birth; for birth, decay, and death, grief, lamentation, and despair will have come, so far as regards that chain of lives, forever to an end."

The state of mind of the Arahat in which the desire of life has ceased is Nirvana. Dr. Oldenberg has very acutely and patiently considered the various interpretations which have been attached to "Nirvana" in the work to which I have referred (p. 285 *et seq.*). The result of his and other discussions of the question may, I think, be briefly stated thus:

1. Logical deduction from the predicates attached to the term "Nirvana" strips it of all reality, conceivability, or perceivability, whether by gods or men. For all practical purposes, therefore, it comes to exactly the same thing as annihilation.

2. But it is not annihilation in the ordinary sense, inasmuch as it could take place in the living Arahat or Buddha.

3. And, since, for the faithful Buddhist, that which was abolished in the Arahat was the possibility of further pain, sorrow, or sin; and that which was attained was perfect peace;

Thus there is no very great practical disagreement between Gautama and his predecessors with respect to the end of action; but it is otherwise as regards the means to that end. With just insight into human nature, Gautama declared extreme ascetic practices to be useless and indeed harmful. The appetites and the passions are not to be abolished by mere mortification of the body; they must, in addition, be attacked on their own ground, and conquered by steady cultivation of the mental habits which oppose them; by universal benevolence; by the return of good for evil; by humility; by abstinence from evil thought; in short, by total renunciation of that self-assertion which is the essence of the cosmic process.

Doubtless it is to these ethical qualities that Buddhism owes its marvelous success.* A system which knows no God in the Western sense; which denies a soul to man; which counts the belief in immortality a blunder, and the hope of it a sin; which refuses any efficacy to prayer and sacrifice; which bids men look to nothing but their own efforts for salvation; which in its original purity knew nothing of vows of obedience, abhorred intolerance, and never sought the aid of the secular arm; yet spread over a considerable moiety of the Old World with marvelous rapidity, and is still, with whatever base admixture of foreign superstitions, the dominant creed of a large fraction of mankind.

[*To be concluded.*]

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his mind directed itself exclusively to this joyful consummation, and personified the negation of all conceivable existence and of all pain into a positive bliss. This was all the more easy, as Gautama refused to give any dogmatic definition of Nirvana. There is something analogous in the way in which people commonly talk of the "happy release" of a man who has been long suffering from mortal disease. According to their own views, it must always be extremely doubtful whether the man will be any happier after the "release" than before. But they do not choose to look at the matter in this light.

The popular notion that, with practical if not metaphysical annihilation in view, Buddhism must needs be a sad and gloomy faith, seems to be inconsistent with fact; on the contrary, the prospect of Nirvana fills the true believer, not merely with cheerfulness but with an ecstatic desire to reach it.

* The influence of the picture of the personal qualities of Gautama afforded by the legendary anecdotes which rapidly grew into a biography of the Buddha, and by the birth stories, which coalesced with the current folk lore and were intelligible to all the world, doubtless played a large part. Further, although Gautama appears not to have meddled with the caste system, he refused to recognize any distinction save that of perfection in the way of salvation among his followers; and, by such teaching, no less than by the inculcation of love and benevolence to all sentient beings, he practically leveled every social, political, and racial barrier. A third important condition was the organization of the Buddhists into monastic communities for the stricter professors, while the laity were permitted a wide indulgence in practice, and were allowed to hope for accommodation in some of the temporary abodes of bliss. With a few hundred thousand years of immediate paradise in sight, the average man could be content to shut his eyes to what might follow.

LAPLACE'S PLAN FOR PERPETUAL MOONLIGHT.

By DANIEL KIRKWOOD.

ONE of the questions considered by Laplace in the early part of the century, and which he thought of sufficient interest to have a place in his System of the World, has dropped almost wholly out of view. I refer to the relation of the moon to the earth—what it is and what it might have been. The subject is not even referred to in any recent text-book on astronomy. The conclusion of Laplace, however, was not hastily reached, and it remained in his hands, without modification, for a number of years. The great name of the author probably prevented astronomers of the day from undertaking any criticism of his conclusions, and especially from the expression of any opinion on a mathematical question different from that of the greatest astronomer of the century. If Laplace himself ever saw his mistake he never mentioned it, as in the case of a mathematical error pointed out by Dr. Bowditch, the translator of the Mécanique Céleste. Dr. Bowditch's letter informing him of the error was never acknowledged. The mistake, however, was rectified in a new edition. But I proceed with the subject.

If moonlight, it has been said, be always pleasant and desirable—if it contribute to the convenience and enjoyment of life, and if its perpetuity be not inconsistent with the laws by which the world is governed—why has its use been so largely denied us? Why has Nature, or the Author of Nature, left us so great a portion of our time in almost total darkness? Such questions have doubtless occurred to thoughtful minds in all ages. The subject is one of interest and curiosity. Let us briefly consider some of the possible relations of a satellite to its primary, including a special case proposed by Laplace.

Sir Isaac Newton, who preceded Laplace by about a century, had found evidence, as he claimed, that the material universe is the work of an all-wise designer. The author of the Mécanique Céleste, the greatest mathematical astronomer of his age, seldom discussed questions of a moral nature; but, not accepting Newton's views on the doctrine of final causes, or the doctrine of design in the material world, he took occasion to point out a so-called failure of Nature in adapting means to ends. If the moon was designed to give light by night, the purpose, he said, had largely failed, and he (Laplace) could suggest a better plan. But the entire passage is quoted as follows:

"Some partisans of final causes have imagined that the moon was given to the earth to afford it light during the night. But in this case Nature would not have attained the end proposed, since

we are often deprived at the same time of the light of both sun and moon. To have accomplished this end, it would have been sufficient to have placed the moon at first in opposition to the sun and in the plane of the ecliptic, at a distance from the earth equal to the one hundredth part of the distance of the earth from the sun, and to have impressed on the earth and moon parallel velocities proportional to their distances from the sun. In this case, the moon, being constantly in opposition to the sun, would have described round it an ellipse similar to that of the earth. These two bodies would then constantly succeed each other, and as at this distance the moon could not be eclipsed, its light would always replace that of the sun." *

The plan here proposed was one of startling boldness; but without assuming to defend the doctrine of final causes, it must be said in fairness that to afford light by night had never been claimed as the *only* design for which the moon was given. Other purposes no less important may be readily imagined. Moreover, the moon's light at the distance named by Laplace would have been little more than one twentieth part of that afforded by the full moon at its actual distance, or less than that of our new moon two days after the change. Such moonlight, though perpetual, would have had little comparative value. Again, the tidal effect upon the earth would have been scarcely perceptible. But without further insisting on these points, however important, let us compare the proposed arrangement with that of Nature. Would it have involved nothing inconsistent with the system's stability? or would its adoption have resulted in depriving our world of the moonlight enjoyed in the existing system?

The annexed figure † illustrates Laplace's proposed arrangement. The distance at which he would have placed the moon from the earth is about 1,000,000 miles, or a little more than four times the actual distance. An eclipse of the moon is caused by its falling into the earth's shadow. This can extend into space only about 860,000 miles, and, as this is less than the distance of Laplace's proposed moon, the latter, as he remarks, could never be eclipsed.

Let us suppose the distance of the moon from the earth to be increased, what changes would be effected in the observed phenomena? At 478,000 miles, twice the present distance, the length of the lunar month would be seventy-seven days; the quantity of moonlight would be one fourth of what we now enjoy; and the height of tides in the open seas would be but a few inches. At 717,000 miles, three times the present distance, the length of the month would be one hundred and forty-two days, and the appar-

* Système du Monde, Hart's translation, vol. ii, p. 79.

† Figure omitted.

ent size of the moon would be reduced to one ninth of its present value. With increasing distance the phenomena would still further change, till at the orbit named by Laplace the month would be equal to the year, and the moon's enlightened hemisphere would be turned constantly to the earth. But the great astronomer's dream of perpetual moonlight—how long would it be realized ?

Another question of vital importance is here involved in the theory under consideration—the variation of the earth's attraction on the moon supposed to be removed to a greater distance. This variation is more rapid than that of the sun's attractive force on the same body, as the distance between the sun and moon is four hundred times that between the moon and the earth. At what point, then, would our satellite escape from the earth's controlling influence and commence to revolve as an independent planet about the sun ? This question, strangely enough, seems never to have received Laplace's consideration ; at least his statement was continued without change in a later edition of his Système du Monde. This problem touching the moon's limit of stability was not solved until sixteen years after Laplace's death.*

The relative distances as well as the direction and force of the impulses necessary to produce the required motions in the scheme of Laplace were given by himself in the paragraph quoted. The state of things at double the moon's distance has also been estimated. At four times the distance, or somewhat more, we find Laplace's position of perpetual moonlight; but just here we find the region where the earth loses its control over the moon's motion. The moon escapes from the *earth's* influence, and henceforth owns allegiance only to the sun. She becomes a *primary* planet, with a year somewhat greater than ours and a day of doubtful length. As regards the earth, lunar tides can no longer exist. Moonlight and the moon would forsake us together; and the new condition of things, could it be realized, would be worse than the first.

From the case here considered we may learn (1) that dogmatism in regard to the divine plan in the structure and constitution of the universe is not always wise. Final causes may engage the attention of thoughtful minds, but who shall set limits to their extent or application ? "Touching the Almighty," said Elihu, "we can not find him out." (2) The wisdom manifested in the adaptations of material things around us transcends that of man's highest efforts. Attempts to disparage the skill of Nature's handiwork must end in failure and disappointment.

* The solution was first given by M. Liouville in 1842.

The failure of the theory proposed in the case of the earth and moon is no less striking when applied to Mars, Jupiter, or any other planet. In every instance the position of the satellite assumed to afford permanent moonlight would be one of instability. This striking fact renders the oversight of Laplace the more remarkable. It may be stated, however, that by the arrangement of several moons about the same planet almost, if not entirely, perpetual moonlight might be possible. The system of Jupiter and his moons furnishes a clear illustration.

In conclusion, we have seen, then, that where one of the greatest mathematicians of all time suggested a change—a so-called improvement in the system of the world—the modification would have left us without tides, or, worse still, the earth in the system proposed would have lost control of her satellite, and we would not only have been deprived of moonlight, but also of the moon itself.

ELECTRICITY AT THE WORLD'S FAIR.

By CHARLES M. LUNGREN.

II.

THE facility with which a high temperature may be obtained with electricity, and the heat controlled and located just where it is wanted, makes this agent peculiarly well adapted to the heating of metals for welding and forging purposes. This was early recognized by Prof. Elihu Thomson, to whom the development of the art is chiefly due, and who has devised a great variety of apparatus capable of performing all classes of work, from the simple welding of two wires to the making of large and complicated joints.

The principle involved is very simple. If a current be passed through a rod or wire, heat will be developed in it if the current be of sufficient volume. If this circuit, instead of being formed of a continuous conductor, be a broken one, such as would be furnished by two rods whose ends abut, the heat will be developed first at the surface of con'act, as this is the point of greatest resistance, and then spread along the rods. And if, while the rods are in a heated condition, they be pressed together, they will become strongly united and form a perfect joint. On account of the radiation of heat from the surface and the cooling effect of the air, the rods become hotter at the center than at the surface, which is the reverse of what happens with a forge-heated bar, where the heating begins at the outside and gradually extends to the interior. This feature of the electric welding process has an important advantage in producing a firmer and more perfect joint, and

in diminishing the formation of surface scale. Tests show that the electric weld is much stronger than that made in the ordinary way in a forge, and, indeed, is in some cases stronger than other parts of the bar.

The machines designed by Prof. Thomson for carrying out this method of welding are extremely simple, the mechanical part consisting essentially of one or more pairs of clamps to hold the pieces to be united, and means for pressing them together while in a heated condition. In operating the machines the current is turned on by the workman by means of a switch; but Prof. Thomson has taken advantage of the movement of the pieces toward each other while the weld is being made to break the circuit, thus rendering the operation automatic and insuring the equal heating of the welded pieces. In machines for wire and small rod the welded wires and rods are pressed together by means of springs, but in those for larger work the necessary pressure is applied by hydraulic apparatus. The necessity for this will be appreciated when it is stated that the pressure requisite for steel is 1,800 pounds to the square inch, that for iron 1,200 pounds, and for copper 600 pounds.

Electrically the apparatus is as simple as it is mechanically. The alternating current, which has shown itself so flexible in the hands of the engineer in other departments of electrical work, is here called into requisition. Through the medium of converters the high potential machine current is transformed into others of great volume and low voltage suitable for this class of work. Currents of this character are rendered necessary by reason of the fact that all metals are very good conductors of electricity, and can therefore be heated only by currents of great amount. These currents range, in fact, from a few hundred ampères to eight and ten thousand. The voltage, however, is very low, rarely being more than four or five volts, and in large and heavy work sometimes not more than a single volt. On account of this very low electrical pressure all danger from the current is eliminated and the apparatus may be handled with the same freedom as any ordinary metal-working machine. In the distribution of the electrical appliances the current is usually generated by a machine conveniently located with reference to the source of power, and the current carried by wires to the welders, where the transformation takes place, each welder being provided with its own converter, proportioned so as to supply the character of current best suited to the special work of the machine. The current is under perfect control by means of regulating devices operated by the workman, the usual device employed being a reactive coil. The range of work possible with this method of welding is very great. It not only may be used in forming all ordinary welds with iron and steel, but

has been found capable of welding metals which have heretofore resisted all attempts to unite them direct, and which have therefore had to be brazed or soldered. Wrought iron, copper, brass,

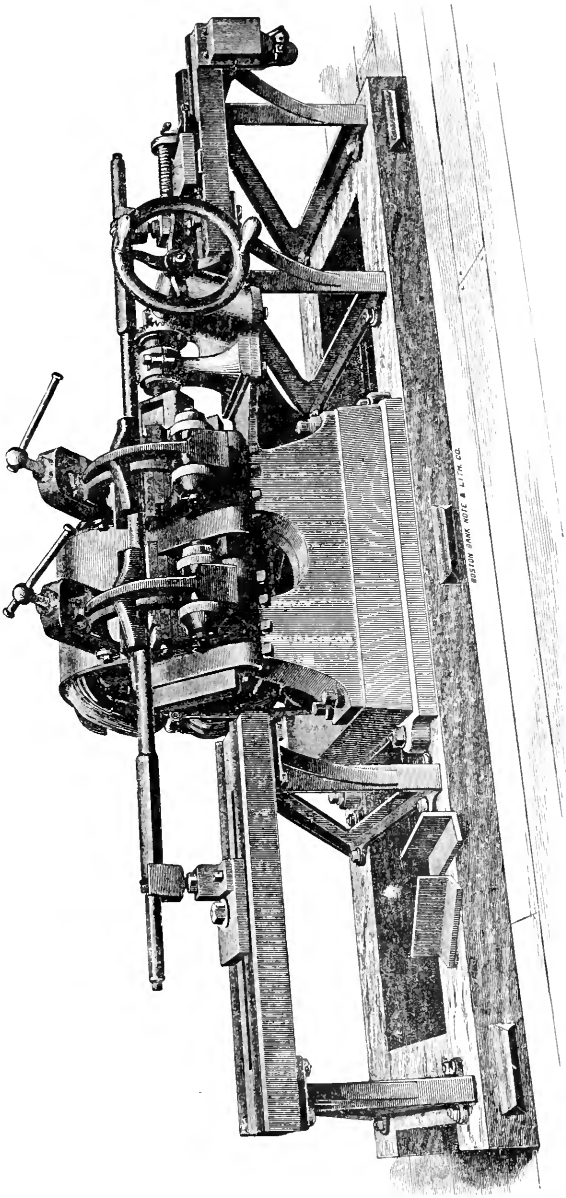


Fig. 8.—Carriage-axle Welder.

silver, platinum, gold, aluminum, and even cast iron may not only be welded together, but may also be welded to one another in many different combinations. In addition to welding, all sorts of brazing may be done by this method, as the same heat which

will soften a metal sufficiently to allow it to be welded will, of course, render the various solders fluid.

The process is, moreover, on account of the extreme rapidity with which welds may be made, and the ability to concentrate all the heat at the point of union, a very economical one. Practical commercial work has shown that the cost of the coal burned under the boiler to produce the electricity is just about that of the coal used in a forge to do the work in the old way, and that the saving in time, and hence labor cost, is clear gain, to say nothing of the cleanliness of the process, the freedom from deleterious materials in contact with the metal, such as sulphur and ash, and the advantage of having the work always in clear view. How great the saving in time is may be appreciated by the following statement of actual work vouched for by Mr. Frederick P. Royce and cited in a paper read by him before the National Association of Carriage Builders:

Axle Welding.

1″	round axle	requires	25	horse power	for	45	seconds.
1″	square "	"	30	"	"	48	"
$1\frac{1}{4}$″	round "	"	35	"	"	60	"
$1\frac{1}{4}$″	square "	"	40	"	"	70	"
2″	round "	"	75	"	"	95	"
2″	square "	"	90	"	"	100	"

Tire Welding.

1″ × $\frac{3}{16}$	tire	requires	11	horse power	for	15	seconds.
$1\frac{1}{4}$″ × $\frac{3}{8}$″	"	"	23	"	"	25	"
$1\frac{1}{2}$″ × $\frac{3}{8}$″	"	"	23	"	"	30	"
$1\frac{1}{2}$″ × $\frac{1}{2}$″	"	"	23	"	"	40	"
2″ × $\frac{1}{2}$″	"	"	29	"	"	55	"
2″ × $\frac{3}{4}$″	"	"	42	"	"	62	"

The process, though only introduced into commercial work in 1888, has gone largely into use, and electric welders now form a part of the regular equipment of the carriage and bicycle factory, the boiler and tool shop, the wire mill, the yard of the shipbuilder, and the thousand and one establishments which have to do with the working and shaping of metals. It has been applied with marked success to the joining of the parts of railway frogs, of chairs to rails, and other heavy work, and in ordnance work, to the manufacture of shell and shrapnel. One of the most novel uses to which the process has been put is now to be seen in Boston on a section of the West End street railroad. This is the welding of the ends of the rails together without removing them from their places in the track, the object being to render the line of rails efficient return conductors for the current used with the trolley cars. To accomplish this the necessary apparatus is mounted upon a car provided with driving motors to enable it to

be moved along the track as the work proceeds. The current to supply both the motors and the converters is taken from the line wire by the ordinary trolley arm. In making the weld the earth is removed from about the joint, clamps applied, and the current sent through the rail ends until these are brought to a welding heat.

Another method of utilizing the electric current in the working of metals shown by the Thomson Company is due to M. de

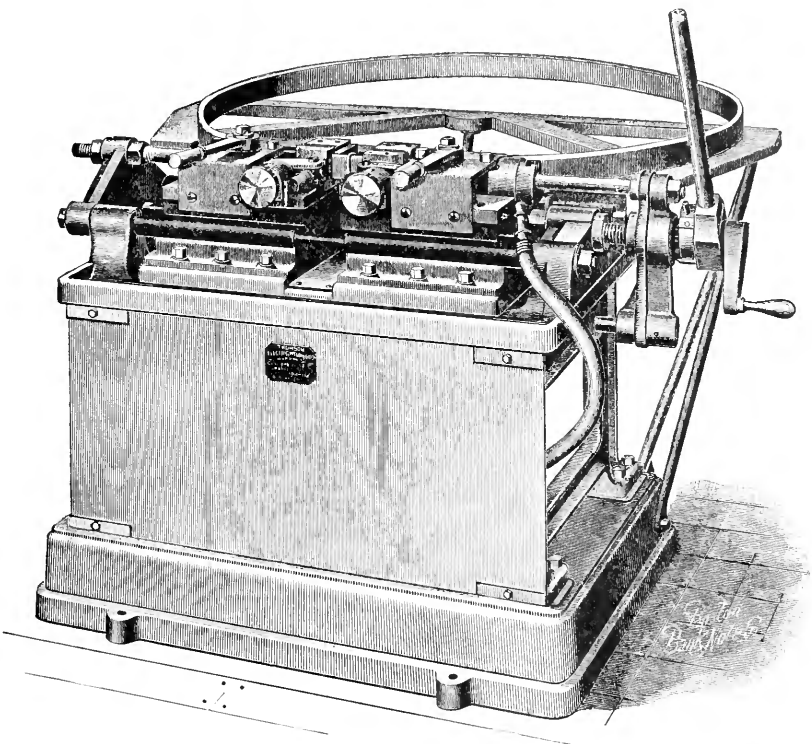


Fig. 9.—Tire Welder.

Meritens, a well-known French inventor and constructor of dynamos. This consists in forming an arc between the object to be heated and a movable electrode carried in the hand of the operator. In this case the work forms one terminal of the electric circuit and the hand tool the other. This hand tool consists simply of a stick of ordinary arc-light carbon mounted in a suitable holder, and connected with the circuit by a flexible cable.

The workman is by this simple device provided with a tool of remarkable range and flexibility. He has at his command the enormous temperature of the electric arc, yet in such a form that he can vary it from the heat of a taper to full intensity, and reach with it parts of his work that would otherwise be inaccessible.

It is chiefly used at present in forming the longitudinal seams of tubes and vessels, and in filling in blow holes and other imperfections in castings. In this latter operation additional pieces of metal are fused into the openings, rendering the castings as sound and good as though they had come from the mold in perfect condition.

A method of using the electric current, substantially the same as that of Thomson, is employed by Mr. George D. Burton, and shown in operation at the exhibition by the Electrical Forging Company. Mr. Burton's object is not, however, to heat the metal simply at the line of juncture and then complete the union of the parts in one operation, but to heat a piece of metal either throughout its entire length or any particular part, and then forge it into shape by the hammer or special machines designed to produce particular forms. He uses, as in the Thomson apparatus, the alternating current transformed to one of great volume and low voltage; but instead of employing a number of converters, each adapted to the special work in hand, he makes one large one suffice, tapping this at as many points as desired. The holding device for the bars to be heated consists merely of a massive pair of copper clamps easily manipulated by the workman, and from which the work may be quickly transferred to the anvil or shaping machine.

The economy in time of electric heating is very strikingly shown where long bars and rods are heated. For instance, a round bar of tool steel, seven eighths of an inch in diameter and eleven inches long between the clamps of the machine, may be brought to a welding heat in one minute by the expenditure of thirty-two horse power. A bar of the same material, half an inch in diameter and five inches long, requires but twenty-seven and a half horse power for half a minute; while one an inch square and twelve inches long is raised to a white heat by thirty-six horse power in two minutes and a half. Generally speaking, the electric heating may be done in a tenth of the time required by the forge or furnace, and the power required is between three and four horse power per cubic inch of metal heated. The feature of electric heating already noticed of a bar becoming more highly heated at the center than at the surface when exposed freely to the air, is shown in a very convincing manner at this exhibit by fusing the core of an inch bar without it losing its shape. A consequence of this internal heating of a bar is the holding of its heat much longer than a forge-heated one, permitting of forging operations with one heat which would require two or three by the old method.

One of the most striking things in the exhibition—remarkable on account of being so entirely out of harmony with all our ideas

of the conditions under which we expect to see heat generated—is the apparatus to be seen in this exhibit which may be appropriately termed the "water-pail forge." This consists of an ordinary wooden pail filled with water into which dips a metal plate connected with one terminal of the electric circuit. The other terminal is attached to a pair of blacksmith's tongs, with which the operator picks up and holds the piece of metal to be heated. Immediately upon his plunging this into the water the liquid begins to sputter and the metal to glow, until in a few seconds it is brought to a welding heat and is then speedily melted. The heating is so rapid that neither the water nor the metal a few inches away are more than slightly warmed. This curious phenomenon appears to be due to the localization of the resistance of the circuit at the surface of the heated metal by the interposition of a layer of hydrogen between the metal and the liquid. This is the explanation offered by two Belgian engineers who recently brought out the process abroad with apparently no knowledge of its prior use in this country. In their apparatus they used a glass jar lined with lead which formed the positive pole. The water was acidulated to render it conducting. When the circuit is completed by the immersion of the metal to be heated the current decomposes the liquid, the oxygen going to the lead plate and the hydrogen to the iron or other immersed metal and preventing any direct contact of the metal and the liquid. As hydrogen is a very poor conductor of electricity, the resistance would then be localized at the surface of the metal plate, with the result of heat being rapidly developed at this point. An American investigator, Mr. Jules Neher, who has experimented with the process, regards the heating as being due to the formation of an arc between the heated metal and the liquid, as he has observed that the heating does not take place if the metal be immersed before the current is turned on, the energy of the current then being spent in the electrolysis of the liquid. His explanation is that immediately the metal touches the liquid hydrogen begins to be liberated and, interposing itself between the metal and the liquid, draws an arc in the act of pushing the two asunder. This arc formed under water quickly raises the metal to a high temperature. Whatever the precise explanation, it certainly is a most astonishing thing to see pieces of iron and steel glowing at a white heat and running away in melted globules while surrounded by water. The capabilities of the apparatus would appear to be almost unlimited, and it is not too much to say that it is destined to find wide application in the arts. The operator has at his command the practically unlimited energy of electricity, and should be able to reach temperatures with it heretofore unattainable. The Belgian experimenters are reported to have succeeded in fusing carbon, and it has been suggested that

it is within the range of possibility that we may in this way reach the solution of the problem of the artificial production of diamonds.

Another and very different use of the heating power of the electric current is its application to cooking and house heating. Attempts have been made for some years now to adapt the current to these purposes, and what has been accomplished in this

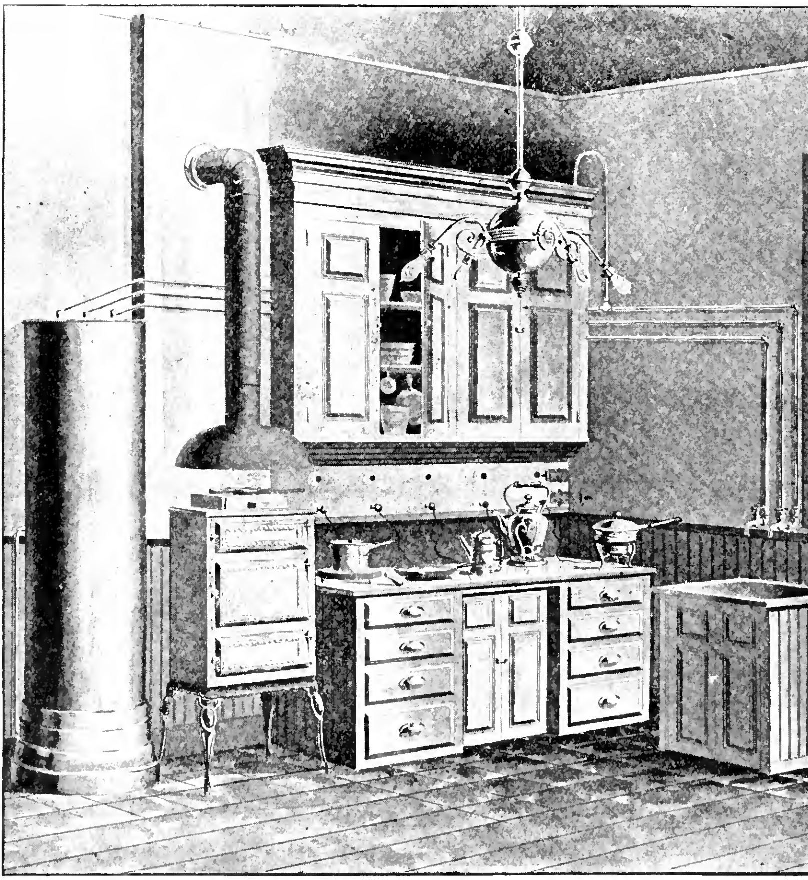


Fig. 10.—An Electric Kitchen.

direction is to be seen at the exposition. After considerable experimenting the final form which has been given to the apparatus for such use as hot plates, broilers, and water heaters is that of a wire imbedded in enamel such as is at present used upon kitchen utensils. The wire most commonly employed is German silver, though in some cases platinum has been used. In applying this construction to a flatiron, for instance, the base of

the iron is made in the form of a shallow tray into which the enamel is poured. The wire in the shape of a zigzag forms a flat coil completely surrounded by this insulating compound. A hot plate suitable for heating a kettle of water or baking griddle cakes is made in the same way, and a grid or frame with gutter-shaped bars filled in with the enamel serves as an oven heater, a sufficient number of these grids being disposed at various parts of the oven. Operations such as the broiling of steak are performed on a modified form of broiler in which the ordinary wires give place to narrow inverted U-shaped bars. The heating wires are carried through the hollow space of these bars and imbedded in enamel. For the heating of water in special vessels, such as the ordinary kitchen boiler, the vessel is made with a bottom in the form of a hot plate. In all the utensils shown at the exhibition the enamel used is of the ordinary gray variety which requires firing, but an enamel for this purpose has been introduced in England which needs no baking. When it comes to heating either by direct radiation or through the medium of hot air, the form finally adopted is that of a coil of wire wound over a pottery or porcelain center and partially inclosed in an iron case. For car warming, heaters are placed under the seats, and located so that they can radiate directly into the car, wire guards being placed in front of them to protect the clothing of passengers. Such heaters have been introduced quite extensively into trolley cars, and are said to have been found economical when everything is taken

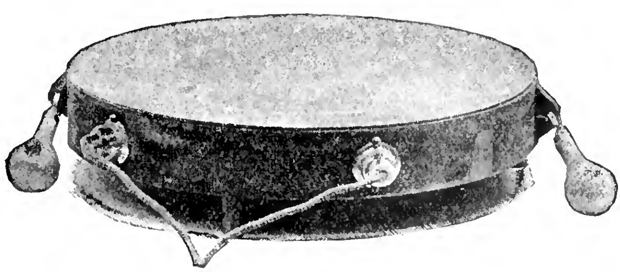


FIG. 11.—ELECTRIC HOT PLATE.

into consideration. They require no attention, and take up no room which would otherwise be occupied by passengers, both items of economic advantage in such a use. Heaters designed to take the place of the hot-air furnace are constructed in the same general manner as those for car use. The plan is to place a large primary heater in the cold-air box of the ordinary furnace, and then subsidiary heaters just inside the grating of registers, by means of which additional heat may be obtained when the main heater is insufficient. All classes of apparatus are made to be used with either an alternating or continuous cur-

rent, and adapted to be attached directly to the ordinary electric supply circuits.

Ideal this method of cooking and heating certainly is, and ideal it is likely to remain. There are many things electricity can do—many things it is doing which were without the bounds of our expectation of even yesterday—but supplying heat in economic contrast with coal and gas for the ordinary operations of the household is not one of them. This is, of course, upon the condition that the current is generated by the combustion of fuel. In situations in which the current is produced by water power, and in which fuel is scarce and dear, the unit of heat furnished by electricity may very well bear comparison with that by direct combustion; but that you can not start with combustion, suffer the tremendous loss of the steam engine, the various losses of the electrical apparatus, pay a profit to the electric supply company, and still compete in point of economy with the primary process of combustion, would seem to be a proposition too clear to need demonstration. Looked at from the point of view of percentages, the steam engine makes a return of but ten per cent of the heat energy of the fuel, the dynamo can hardly be depended upon in practice for more than ninety per cent, and the converter, when this is used, may be counted to absorb ten per cent of the energy delivered to it. This leaves in the one case but nine per cent and in the other a little over eight per cent of the original energy at the disposal of the consumer. Some of this must inevitably be lost in the final heating operation, for, though the apparatus be designed never so well, it can not have an efficiency

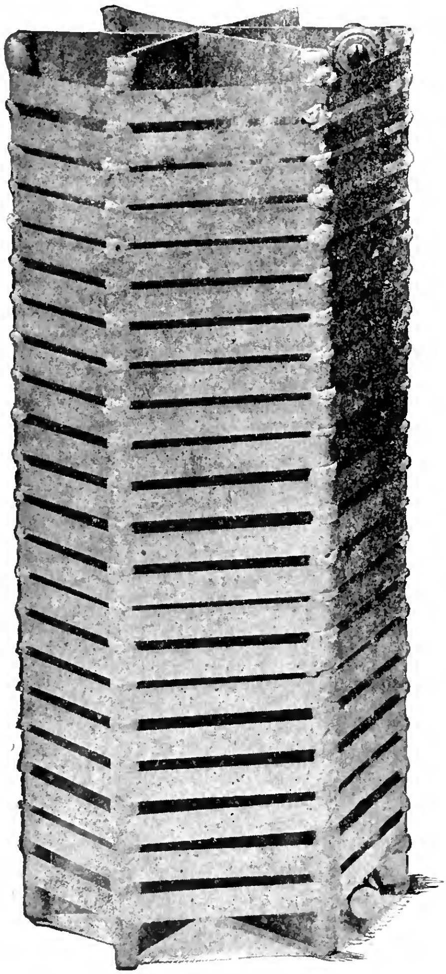


Fig. 12.—Electric Coil Heater.

of a hundred per cent. The consumer, therefore, can have in an available form not more than ten per cent and probably not over seven per cent of the heat in the fuel with which the cycle of operations started. This is an efficiency much below that obtainable from the direct combustion of the fuel by even the most wasteful methods, and at no price at which electrical energy can be furnished could the two forms of heating be brought on the plane of economic equality. A direct comparison of the actual number of heat units (pound-degree Fahr.) present in each instance will show with perhaps greater clearness the economic relations of the two methods of heating. A horse power of electrical energy is equivalent to 2,565 heat units per hour. A pound of coal contains 13,000 heat units, and costs, with coal at five dollars per ton of 2,000 pounds, a quarter of a cent. If we give to the coal an efficiency of but ten per cent, it will require two pounds to equal the available heating power of the electrical horse power, allowing that all the heat in the latter case is utilized. This will cost the user half a cent, and making due allowance for the collateral expenses of coal as a fuel, such as kindling, removal of ashes, and cost of handling, it is very evident that electricity can not hope to offer any economical competition. The commercial promoters of electrical heating count upon a charge to the consumer of five cents per horse power per hour for cooking purposes, and a cent and a half for heating purposes. This is very much under the figures at which electric power is now being furnished for lighting purposes—the charge for this being at the rate of from twelve to fifteen cents per horse power-hour—but it is proposed to make the same discrimination between light and heat that the gas companies have instituted. At the lower figure electric heating is nearly three times, and at the higher nearly ten times, as expensive as that by coal, allotting to coal the above very low duty. But coal has no such low efficiency. The radiant heat from hard coal is fully twenty-five per cent of the total heat generated, and of this fully one half is utilized in a grate fire, which is the most wasteful of the heating devices in use. In the best forms of grates which have been devised, in which the surplus heat is used to warm the air supply of the room, as much as thirty-five per cent of the heat may be made available, while in close stoves of the best patterns the efficiency will not fall below seventy per cent.

With gas the comparison is of course much more favorable, as here the cost of a unit of heat is much greater than in the case of coal. Illuminating gas has a heating value of six hundred and fifty to eight hundred heat units per foot, according to the quality of the gas. At the lower figures it requires a trifle under four feet to equal the heat value of an electrical horse power.

Gas may be counted upon for a duty of seventy-five per cent; so that the amount necessary to do the heating work of the electrical horse power will be five and a third feet. This, with gas at a dollar and a half per thousand will cost ·078 of a cent, and with gas at a dollar a thousand—a not uncommon price at present in the United States—will cost but little more than half a cent. For cooking purposes the two methods of heating are on an equality in the matter of ease of manipulation, absence of collateral expenses, and limitation of the use of the fuel to the exact time required to perform the operation in hand. Their value to the householder is, therefore, in direct ratio to their cost. Gas clearly has the advantage of being from five to ten times the cheaper source of heat, an advantage so great as to make its supremacy secure. With the cheaper forms of fuel gas which have grown up, and will doubtless come into larger and larger use as the lighting field of gas dwindles, electricity can have even less chance of competing. This method of heating will doubtless find a field of its own, in which its use will be determined by other conditions than those of economy, but it can never hope to take over to itself any considerable part of the heating domain, so long as fuel remains at anything like the present prices.

The Centennial left us in the telephone a new method of communication, which in the time since then has grown into one of the necessities of business life. The Columbian will leave us, in the telautograph of Prof. Elisha Gray, another method of communication which promises to rival the telephone in utility. This new method is not exclusive of the earlier one, but rather supplementary to it. The telephone has endowed us with the power of talking at a distance; the telautograph will confer upon us the ability to write in the same way. It supplies an essential feature lacking in the telephone—a record—and hence becomes available for many uses for which the telephone is unfitted. Mistakes so liable with speech transmission are here impossible, as the receiving instrument reproduces faithfully all the movements of the transmitting pencil, and only a blunder upon the part of the sending operator can cause misunderstanding or confusion. With telautograph exchanges established in cities after the manner of those of the telephone, it will be possible for subscribers to do by means of it much of the correspondence now carried on by mail; and when the system is extended to provide communication between cities, the business man will have at his disposal a method of letter transmission incomparably more swift than the most rapid of fast mails. The extent to which such a system may be used in substitution of mail service will, of course, depend upon the expense attending it, and as this must always be greatly in

excess of letter carriage, it can apply only in cases in which important interests are involved and dispatch is of moment. Such instances are, however, growing increasingly frequent in the modern business world, so that the telautograph, if it prove as successful in actual commercial work as it has in experimental tests, will not lack for a large and profitable field.

The attempts to realize facsimile transmission go back almost to the beginning of telegraphy. As early as 1846 Alexander Bain attempted such reproduction by means of trailing contacts passing over the face of metallic letters at the transmitting end of the circuit, and like contacts sweeping over a chemically prepared paper at the receiving end. When the contacts were on the faces of the letters a current was sent to line; and these current impulses, decomposing the chemical preparation of the receiving paper, made brown or blue marks, according to the nature of the chemical solution, which reproduced in broken outline the original letters. This method of operation was ten years later much improved by Caselli, who transcribed the message or sketch to be sent on a metallic-faced paper, and caused a stylus actuated by a pendulum to traverse in succession all parts of the design. A similar stylus reproduced the drawing or writing on chemically prepared paper at the receiving end. Many attempts have been made by subsequent inventors to adapt this method of transmission to commercial work, but without success. All systems of this kind, it will be observed, depend upon the establishment of exact synchronism between the transmitting and receiving instruments, and this is a condition very difficult to realize in practice. Moreover, the message must first be written either in a special ink or on a special paper, and afterward transmitted, which renders the process slow and necessitates expert knowledge to operate it.

The telautographic method proceeds upon entirely different lines. In this the movement of the transmitting pencil in the hand of the operator causes electrical impulses to be sent over the line, which impulses, through the medium of appropriate mechanism, act upon the receiving pen and cause it to duplicate the movement of the sending one. The possibility of doing this depends upon the geometric principle that the movement of a point in describing a plane curve, no matter how intricate, may be resolved into two rectilinear movements at right angles to each other. In order, therefore, to have the pen at the receiving end of the line follow all the motions of the transmitting one, it is only necessary to resolve the movement of this latter into its right line components and reproduce them at the further end. A point situated at the focus of these lines of movement will then describe the exact motions of the original one. Simple as this

conception is, it has been found by no means an easy one to realize in practice. The first one to attempt the application of this principle to autographic transmission appears to have been Mr. E. A. Cowper. In his apparatus, constructed in 1874, the receiving pen was mounted upon a light armature located between the poles of two electro-magnets placed at right angles to each other. These magnets were included in separate line circuits, and when energized by currents from the transmitting end of the line, attracted the pen armature, causing it to describe a line or curve which was at every instant the resultant of the two right-angled magnetic attractions.

These magnetic attractions were varied in exact accordance with the movements of the transmitting pen by augmenting and diminishing the strength of the current flowing through the magnet coils, and this variation of current strength was in turn accomplished by causing contacts attached to the transmitting pen to pass over the terminals of resistance coils and successively cut out or introduce resistance in the line circuits. On account of the very limited movements which could be given to both the transmitting and receiving pens, the writing had to be done upon a strip of paper which was moved under the pen. The writing with the transmitting pen was done through a square hole about an inch on a side, and the characters had therefore to be made practically one over the other. There was thus but little opportunity for the operator to follow the work and see clearly what he was doing, and only an expert could make an intelligible writing. The details of this method were subsequently much improved by two American inventors, and the apparatus employed for a time in commercial work; but the essential limitations of the method proved too serious a handicap, and the system soon fell into disuse.

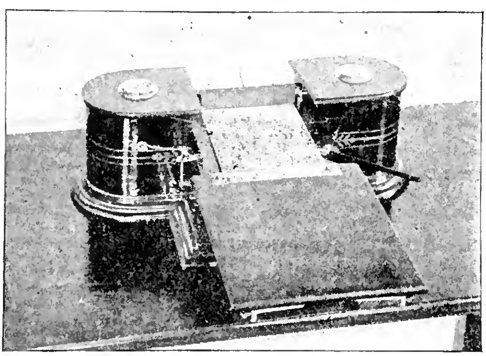


Fig. 13.—Telautograph Transmitter.

In taking the subject up experimentally Prof. Gray at first used the method of a variable resistance, but he speedily abandoned it as impracticable, and adopted the step-by-step method of operation, which he now uses. This consists in causing the transmitting pen to send to the line a succession of distinct electrical impulses, the number of which is governed by the extent of the pen's movement, which are employed, not in affecting the receiv-

ing pen directly, but in controlling the mechanism which actuates it. As the extent of movement of the pens is determined only by the number of electrical impulses, these may be given any desired range, and it becomes possible to use the transmitting pen with almost the same freedom as a pen or pencil in ordinary writing, and to write in the same way—that is, in successive lines extending across a page.

In the final form given to the instruments by Prof. Gray and shown at the exposition the transmitter consists of a box provided with a leaf upon which the paper rests. The paper is drawn continuously from a roll, and is shifted mechanically from time to time by the operator. The writing pen consists of a pencil lead mounted in a holder, to the lower end of which two silk threads are attached. These threads are at right angles to each other, and lead from the pencil to two drums, upon which they are wound in such a manner as to cause the drums to rotate backward and forward as the threads follow the movement of the pencil point. The drums, therefore, move in exact accordance with the rectilinear components of the pen's motion, and it is only necessary to reproduce their motions at the other end to cause the receiving pen to duplicate the movements of the transmitting one. In an earlier form of the transmitter each drum carried an arm, which was swept by its movement over a series of radial electrical contacts, and thus sent a succession of electrical impulses to line. The friction of this moving arm was, however, found to be objectionable, and this arrangement has therefore been replaced by a magnetic device in which a toothed iron disk acting magnetically upon a soft iron lever keeps this in vibration. This lever plays between two contact points, and according as it is upon one or the other of the contacts a positive or negative current impulse is sent by a battery through the line circuit. These current impulses of alternating polarity serve to operate at the receiver polarized relays, which control by means of escapements drums similar to those in the transmitter, which drums actuate the receiving pen.

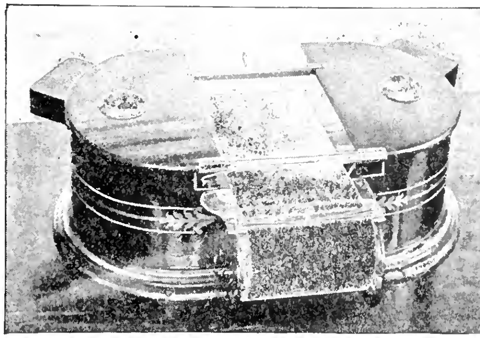


FIG. 14.—TELAUTOGRAPH RECEIVER.

This pen consists of a glass tube drawn to a capillary bore at the end and supplied with a free-flowing ink from a reservoir by means of a rubber tube. It is mounted upon and at the junction

of two light aluminum arms, making a right angle with each other. Each of these arms is attached to its operating drum by means of a cord passing around the drum, so that the rotation of this moves the arm to and fro in the direction of its length after the manner of the ordinary bow drill. The drums are given a tendency to rotate by a small electric motor located in the case of the receiver, and as this rotation is controlled by the polarized relays, which are in turn operated by the current impulses sent out by the transmitting pen, it will be seen that the movement of this latter determines that of the receiving pen, both in amount and direction, and that hence the two pens must move in exact ac-

As written. As received.

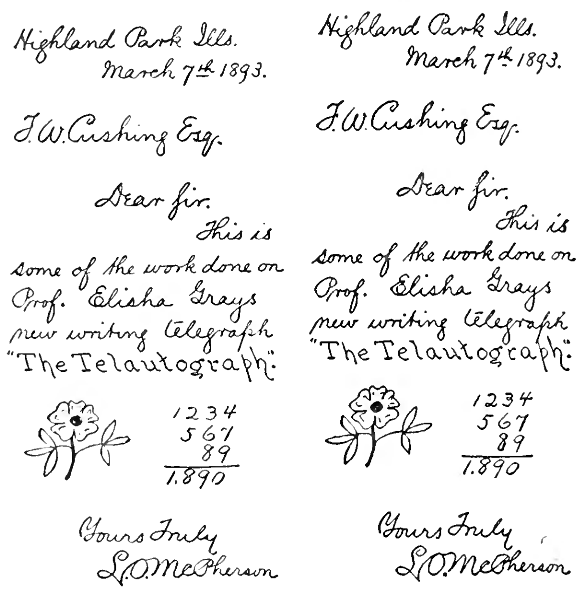


Fig. 15.—Sample Work of Telautograph.

cordance with each other. The mechanism of the receiving instrument is at present a little intricate, and some of the operations to be performed, as the lifting the pen from the paper, shifting the paper, and reversing the motion of the operating drums, require in the present construction two additional line wires, but these, it is expected, can by contemplated improvements be dispensed with, leaving only two line wires for the performance of all the necessary operations. The system has so far been operated over a distance of only thirteen miles; but from the character of the currents used—distinct successive electric impulses—there would seem to be no reason why it should not be capable of operation over as long distances as the ordinary telegraphic instruments.

THE PESTALOZZIAN SYSTEM.

By Hon. GEORGE S. BOUTWELL.

IN the May number of The Popular Science Monthly is an article by Prof. W. W. Aber, entitled The Oswego State Normal School, in which the writer claims for that institution the credit of introducing and promulgating over the country the system of teaching known as the Pestalozzian system.

Upon the statement made the Oswego School was founded in 1853, but upon ideas far away from the system of Pestalozzi, and it was not until 1859 that "lessons on form, color, size, weight, animals, plants, the human body, and moral instruction were prominent."

As to moral instruction it may be said that there was never a time when it was not prominent in the schools of Massachusetts, with object lessons drawn from passing events. In 1859 or even in 1853 nothing could have been gained in Massachusetts from the system of Pestalozzi as to the wisdom or the method of teaching morals in the public schools.

Physiology had been taught in the normal schools of the State and by the aid of the manikin for nearly two decades. It had been introduced and urged by Horace Mann, who disappeared from the Massachusetts schools about the year 1842.

In the year 1859 there were four State normal schools in Massachusetts, three of which had been in existence for about twenty years, and the junior was established in the year 1854.

In all these schools the art of teaching was taught according to the system of Pestalozzi and by well-informed teachers and professors, and with the knowledge that it was the system of Pestalozzi.

In the year 1856 Prof. Hermann Krüsi, who is credited in the article with aiding in the introduction of the system at Oswego, was employed by me in the Teachers' Institutes and Normal Schools, and he continued in that service for about three months in each year until 1860, inclusive. Of the other teachers and professors who were employed in the Teachers' Institutes and Normal Schools in the fifties I may mention President Felton, of Harvard College, Agassiz, Guyot, Alpheus R. Crosby, George B. Emerson, Lowell Mason, and William Russell, all of whom gave lectures and illustrated the art of teaching on the system of Pestalozzi.

I recall examples of the art of teaching grammar, through the aid of an object, given by Mr. Emerson, and I can not imagine that he has been surpassed to this day.

Previous to the year 1859 the art of teaching according to the

system of Pestalozzi had been taught and the practice of the art had been illustrated to thousands of students in the Normal Schools and teachers in the Teachers' Institutes in the State of Massachusetts.

Of the system of Pestalozzi everything was then known that is now known, although the application of the system may have been improved in these thirty years.

Much credit is due to Dr. Sheldon, the founder of the Oswego School, but it is manifest that in 1859 he was ignorant of the educational condition of the country, and consequently he sent across the Atlantic for information which he could have obtained in New England.

As to the system of Pestalozzi there was nothing new but the system. The mode of teaching had been exhibited occasionally and unsystematically through many long years. In my boyhood, in the thirties, the scholars in a country village school were trained in the science of astronomy by outdoor lessons in clear evenings and with the aid of a celestial globe. In Morse's Geography, published in the last century and prepared by the father of the inventor of the telegraph, physical geography is made the primary fact of the study, thus anticipating Guyot, whose system was based on the teachings of Pestalozzi.

The opening questions of Colburn's Mental Arithmetic, "How many thumbs have you on your right hand? How many on your left hand? How many on both hands together?" contain and express the rudimental truths of the Pestalozzian system.

In one particular Pestalozzi stands with Bacon: Pestalozzi did not discover a new method of teaching, Bacon did not discover a new method of reasoning. Each systematized a desultory but long-existing practice.

Great hopes are entertained by manufacturers from M. Chardonnet's method of making silk from wood-pulp, which has been set in operation at Besançon, France. The pulp, having been carefully dried, is treated for transformation into collodion, similar to that which is used in photography. This collodion, which is sticky and viscous, is inclosed in a stiff receptacle, furnished with a filter in the lower end. An air-pump sends compressed air into the receptacle, by the pressure of which the collodion is passed through the filter into a horizontal tube furnished with three hundred cocks, the spouts of which are made of glass and pierced with a small hole of the diameter of the thread of a cocoon as it is spun by the silkworm. The collodion issues through these holes, when the cocks are opened, in threads of extreme delicacy, of which it takes six to make one of the consistence required in weaving. This thread is hardened, previous to winding, by water, which takes up the ether and alcohol of the collodion, when it becomes as resisting and brilliant as ordinary silk. It is made slow of combustion by treating with ammonia.

THE SCIENTIFIC METHOD WITH CHILDREN.

By HENRY LINCOLN CLAPP.

AT a recent meeting of prominent educators in Boston to consider means of promoting work in elementary science, a well-known professor of science said that there was danger that college professors would make out a scheme for teaching science and impose it upon the elementary schools; that the work was likely to be begun at the wrong end.

This led another member to say that not a little danger was to be apprehended from the scientists themselves, because many of them taught as if the scientific method demanded that they should begin with the ultimate, undecomposable constituents of things. There was danger that they would hold to their own conceptions of elements and ignore the child's elements. There was a difference of opinion among their pupils, who became teachers, as to what elementary science meant. Not a few held that science was classified knowledge and but little else, and that no lesson could be a science lesson unless the objects studied were selected in a natural sequence. He added that children are midway between profundities and sublimities, that they know no more about nitrogen than about ether in stellar space, and that they should neither be dragged down nor up to satisfy the demands of some one's so-called scientific method. They have their own starting points, and those should be taken by the teacher.

To this the professor heartily agreed, as did all the others who openly expressed an opinion. Likewise, many other teachers of science readily agree with the points named, when they simply talk about them, but practically deny them in their teaching, for a considerable time at least. It is noticeable that the systematic plans, which they put on paper easily enough at the outset, undergo much modification in course of time as they work with large classes of children. In some unaccountable way the laboratory methods with which they are acquainted prove disappointing when tried with children.

The method of beginning to teach science with ultimate undecomposable elements, and "building up" step by step, with complete sequences and fine inferences, exhibits one phase of science work, especially that done in scientific schools by adult students. In the case of many teachers it seems to furnish all the fascinations and advantages of a thoroughly logical method, and to be in perfect consonance with the educational principle, "From the known to the unknown"; but there seems to be some unreasonable bias or ignorance of facts in the interpretation of the principle as applicable to children. This interpretation is apparently

based on the assumption that the known is simple rather than complex, is in parts rather than in wholes, and that the child's knowledge must of necessity be built up constructively or synthetically. There is some truth in this interpretation, but, followed out with children as far as we too often see it, it involves difficulties and errors of considerable magnitude. In this case, as in others, excessive generalization is dangerous.

Children's natural sequences are from wholes to parts, from the complex to the simple, from the superficial to what lies underneath, from the indefinitely known to the more definitely known, and the mental processes involved are analytical, especially in the early part of their school days. In this case, also, excessive generalization is dangerous. Undoubtedly, children acquire some knowledge synthetically, and as they approach adult life their powers of analysis and synthesis are increased by more frequent use, and no system or method that is excessive in either direction can be rightfully called scientific.

There is a time appropriate for working toward the profound and the sublime, but the start is fraught with danger. No method of teaching whose beginning is not definitely known can be called thoroughly scientific. So far as it fails to interest children, to make them use their own senses in the best manner, to make them think best in their own way, and to develop them best by means of their own activities, so far it fails to be scientific. If it succeeds only by reason of the teacher's great knowledge of the materials to be studied in a special line of work, or his "magnetism" or holding power, rather than by reason of the natural attractiveness of the things studied and the unobtrusive but skillful directive power of the teacher, it is unscientific. If it does not start independent motive powers, it is unscientific. The magnet seems to infuse life into iron filings, when placed near them, but when it is withdrawn they lie inert. Agassiz's method, as carried out by him, started many independent motive powers which are now vigorously at work throughout our land.

Among educational experts there is a difference of opinion as to where the best starting point is in teaching children elementary science. Dr. Mary P. Jacobi would use the flower in beginning to teach children botany, because it is the most attractive, makes the largest impression upon the senses, is easy of apprehension, and leads to the appreciation of specific differences. These are valid reasons, and might consistently be held by all who believe in that natural mode of working which embodies what the child likes, as clearly indicated by the history of the race, and what will develop his faculties in the happiest and most effective manner, such a mode as gave us Agassiz and Darwin.

Miss Youmans would begin with the leaf, on the assumption that it is simpler than the flower, and in tracing its scientific relations deeper intellectual pleasure is received.

The evolution of leaves into flowers is at the same time profound and sublime, outside of children's experiences and beyond their range of thought. Its teaching at the beginning results in cramming, however perfectly it may satisfy the demands of a philosophical but artificial system. Moreover, beginning with roots, as so many systematic teachers have done, and following with stem, leaves, flowers, and ending with fruits as the ultimate work of the plant, although logical to adults, full of regular sequences, and scientific from one standpoint, is unscientific from another. Children do not start to work with plants in that way, unless they are obliged to, but in a way diametrically opposite—attractive flowers and fruits first and unattractive roots last. It is certainly natural, although it may be heathenish and show their natural depravity for them to do so, but to scientific reformers they furnish an extensive field for missionary work in improving on the imperfect works of the Creator.

The uncertainty of where to begin and what to do in elementary science work during the last decade has resulted in much experimentation on the part of superintendents of schools, who are gradually feeling their way down to where the children are. They have entered on the work with unbiased minds, and, while laying no claims to scientific methods in conducting it, have thrown upon the subject valuable side-lights, which, if summarized and classified at a later day, will demonstrate what the scientific method with children must have for a basis.

In this work the scientific schools have played a very unimportant part. They are sending out graduates who do not know the principles of education, who have had but little if any experience with children in the schoolroom. Their efforts for a considerable time are nugatory, to say the least, if not mischievous, and tend to bring science work into disrepute and to make it seem impossible to any but specialists. Not only do they grope around when they attempt to teach the large classes inevitable in a city school, but the professors themselves have but little if any advantage when they "take hold." The methods and results of work in scientific schools are wholly admirable in the fields which such schools have thoroughly and honorably won; but as yet their methods have not been made suitable for different fields lower down. The methods of cultivating the hill country are in many respects unsuitable for the lowlands. The child's way of working is, or should be, different from the adult's. Many instructive illustrations of questionable methods may be given and added to indefinitely.

Not long ago one of the distinguished botanists of this country put into the hands of his pupils a sixteen-page syllabus containing full outlines of lectures on the seed—origin, structure, and uses; the stem and root; the leaf—structure and function; the flower—form and use; the fruit—kinds and functions; ferns, mosses, algæ, and fungi. The whole was covered in six lectures, and the published account bore the title Beginnings in Botany. If the scientific method, or any other, will insure such a work being well done, starting with no knowledge of the subject on the student's part, it has much to commend it to the attention of teachers of science.

Another scientist, who claims to teach by the "natural method," advocates a course of study on animals in the primary schools, which includes the study of the following subjects to be taken up in the order given: starfish, sea urchin, and the same compared; the earthworm; a bivalve shell, clam shell, oyster shell, and the same compared; snail and snail shell; classification of shells; lobster, crab, and the same compared; habits of crabs; and an excellent line of insects.

The attempt here made to select subjects in a natural (?) sequence is attended with some drawbacks. Away from the seacoast all of the material named, except insects, would have to be brought from a greater or less distance, and, being out of the range of the children's common field of observation, would necessitate more or less cramming. Things seen only in the schoolroom do not make the deepest impressions. An extensive use of imported material is directly opposed to Agassiz's injunction to use the material nearest at hand.

Moreover, it is worth while to remember that materials and methods which are serviceable enough in teaching adults often become forced and mechanical in teaching children. It should not be taken for granted that the teacher's sequences, laboriously studied out or taken from some book, are the pupil's sequences, or that he can assimilate them. Prof. McMillan, of the University of Minnesota, says: "No mistake could be greater than to suppose that the sequence most logical for the trained intellect is necessarily the best method of presentation to the novice. In our zeal to eliminate evils of systematic botany we are prone to introduce evils of anatomical botany no less great and equally to be avoided." So in our efforts to prevent pupils from being overwhelmed with information "away over their heads" and almost entirely the product of the adult mind, we have taken on the shackles of a rigid system or scientific method, also the product of the adult mind for the adult mind, and between the two methods the children have generally come to the ground.

One of the best illustrations of the uncertainty that exists as

to the best materials and methods to be used in teaching elementary science may be found in the public schools of Boston. About a dozen years ago a course in science for elementary schools was formulated and an attempt made to carry it out. The systematic study of animals was begun in the lowest grammar grade, fourth year in the elementary course, and the specimens to be studied in order were thus laid down: "Sponge and coral compared; starfish and sea urchin (dried specimens) examined and compared; oyster, clam, and snail compared; shells of different forms compared." The lessons that preceded the study of the objects named were information lessons on "grass-eaters, flesh-eaters; animals with hoofs, claws, wings; land animals, water animals, etc." Systematic mineralogy, without any previous work on minerals, was begun in the sixth grade on these mineral substances: "(1) metals that are native minerals (gold, silver, copper); (2) metals from ores (lead, zinc, tin, iron); (3) non-metals (sulphur, carbon); (4) gases (oxygen, hydrogen); compounds: iron rust, carbonic-acid gas."

This course, of which parts have been given as illustrations, was the best product of one of the leading spirits in science work, aided by the advice of teachers of science in the scientific schools of that time. It is questionable whether the scientific schools of to-day can formulate a better course for children. The method employed to carry out the course satisfied the demands of those who were regarded as experts in science work as to elements, natural sequences, synthesis, and system; but although the work was pushed vigorously in the beginning, it soon began to stick, and finally failed altogether. Of course, scientists called the work scientific, and teachers who were simply literary thought it discreet not to question that decision; but it is evident now that a very important scientific element was lacking—namely, the science of success, knowing how to succeed; and that lack resulted from a failure to recognize the child's standpoint.

It is claimed by teachers of science now that the reason why such a course in natural science can not be carried out successfully is the lack of specialists to teach in every class the particular subjects named by the method used in the scientific schools. Doubtless an adequate supply of specialists would suffice to force the study to an apparently successful result; but the necessity for the application of so much force to a study that has the term "natural" so frequently applied to it should make us pause and consider whether the resistance to be overcome is not caused by some artificiality into which we have unconsciously drifted. *Natural* education is unconsciously easy, and difficulties increase as it becomes artificial. "The lines of least resistance" should not be overlooked in any educational plan.

The former course in science in the Boston schools having failed, a somewhat radical change of base in such work has recently been made. In the first place, the term "elementary science" is not approved by many teachers who adhere to the dictionary meaning of the term. They say that no real science work can be done in elementary schools, and will not admit that elementary science means *simple knowing*, when used to designate children's acquisitions of knowledge at first hand, but insist on limiting the term to the scientist's elements and organized knowledge. They give an unscientific excuse for failing to teach science in a natural and successful manner. On the whole, "observation lessons" is an acceptable term to use in designating children's work with natural objects. If a mere name be made a stumbling block, it had better be changed at once.

Now, the course in the Boston schools requires "observation lessons" on the "structure and habits of familiar and typical articulates and vertebrates," including the frog, fish, robin, hawk, hen, duck, cat, dog, pig, rabbit, horse, and cow, in the fifth grade. In the sixth grade the work is continued by observation lessons on "typical and familiar specimens of radiates and mollusks (sponge, coral, starfish, oyster, snail, jellyfish)," and ends with observation (?) lessons on the elephant, whale, seal, cochineal, and ostrich.

The study of minerals is begun in the sixth grade, as before, but the materials used are common rocks, instead of native minerals and chemical elements, which are studied in the ninth grade.

In this radical change from the former course there is an evident intention to depart from the so-called scientific standpoint and approach the child's point of departure; but those inevitable errors have been made that always attend the laying out of courses on paper before working them out carefully with many large classes of children.

It is manifest that there can be no proper observation lessons —not to mention what commonly pass for science lessons—on the whale, the seal, the ostrich, etc., in an ordinary city grammar school. The same may be said of the frog, the hawk, the pig, the cow, etc. Such things can not be brought into the schoolroom with compensating advantages. If pictures are made a substitute, the work with them deserves no better designation than information lessons, and speedily degenerates into first-class cramming.

Concessions to the scientists may be seen in the requirements in regard to the structure and classification of articulates and vertebrates in the fifth grade, typical radiates and mollusks in the sixth grade, and the order of studying minerals in the ninth grade, beginning with elements and working up synthetically to com-

pounds. Such study is unquestionably better adapted to the ninth grade than to the sixth or lower grades. The classification of radiates, articulates, and vertebrates has never had marked success in high schools, and nothing worth mentioning has been done in that line in grammar schools.

After all that has been done in formulating courses in elementary science on paper in Boston, not to mention other places, the work has never been in a more unsatisfactory condition than now, since the first course was introduced into the schools a dozen years ago. What has been called the scientific method has failed in the elementary schools, if not in the high schools; and now another overturn of the course in science work is taking place in Boston.

How far the traditions and methods of the scientific schools are responsible for the delay in reaching the child's point of departure for things scientific can not be set down with exactness; but their isolation and conservatism certainly have not furnished them with such conditions as could be turned to the advantage of children just starting out into school life.

In writing, we no longer adhere to pothooks and trammels; learning the alphabet and spelling *a-b abs* are not our best means of teaching reading; mere ciphering with abstract figures in arithmetic has been superseded by more rational processes; committing to memory paradigms and grammatical rules has failed to enable students to use language fluently and correctly; nevertheless, all those things were formerly considered essential elements, and the only proper starting points for scientific teaching in the lines of work indicated. So the starting points of the scientific schools must be discarded for more natural and appropriate ones in the elementary schools. We shall use the children's elements, and discover upon what they work with interest and independence, how they work, what will best call out their activities and enable them to teach themselves, and by what means they can express their ideas best. The basis of instruction in elementary science must be the child's natural method of working upon his own elements, the things that are simple to him. His elements of expression in language are *words,* not the elements of words; in drawing *outlines,* not points and straight and curved lines; in science, *what he knows at first hand* through the medium of his own senses—*superficies, externals,* not internals, anatomy, and remote elements. A lack of knowledge of this side of science work will make all other sides ineffectual.

The science of teaching demands full recognition of an adequate *presentation* of the subject to be taught. The normal schools rightly claim that good *reproduction* naturally follows good presentation; but unfortunately they too often assume that

the teacher must make the presentation. The consequence is, that all the points of a subject are set forth as clearly as possible by the teacher, and a summary closes the first stage of the instruction. Teachers often acquire excellent reputations by thus illustrating their skill in developing a subject logically and bracketing out the syllabus of the work, as some one has said, "on a rod of blackboard." Then comes the reproduction or presentation by the pupil, and, if he does not reproduce the instruction well, the subject is thought not to have been presented clearly enough, and often the presentation is repeated. This method is said to be psychological and scientific; nevertheless, it induces passivity, a habit of waiting to be told what to do, and a wrong attitude for the work of investigation. It is distinctively a literary method that is carried over into science work with disastrous results.

The best presentation of a thing is made by the thing itself, which must be suitable for the grade in which it is used, being simple in form, color, and parts for low grades—not necessarily of simple and regular form, nor of one color, nor of two parts. "The presumption of brains" must apply to the youngest pupils of school age. Experience shows that pupils who are permitted to draw and describe in writing simple, natural objects, guided only by a very few words written on the blackboard, acquire such a habit of application and power of expression as can be developed in no other way as well or as soon. They are so pleased with the expression of their own ideas, when they have been well started, that the disposition to appropriate other persons' ideas to save themselves from thinking or to copy the expression of them is counteracted. Their most imperative needs are *opportunities to work by themselves, skillful guidance, and generous encouragement.*

The question-and-answer method is the principal method of instruction in both the normal schools and the scientific schools. It appears to be the most scientific method generally known, and accordingly is *the* method used in teaching science. The teacher, in giving a lesson on a natural object, prepares her questions carefully in a systematic order, anticipates the probable answers of the pupils, and determines the exact answers which they must give at last. To do this heavy work a multitude of "leading questions" is necessary, and to ask and answer the questions consumes much time and calls for exhausting labor on the part of the teacher. The questions are put in order with considerable difficulty, which varies with the amount of freedom permitted, and the pupils are said to be led to investigate for themselves. The answers of the brightest pupils are frequently written on the blackboard, where the dullest pupils may read them and try afterward to pass them off as their own. The process insures con-

siderable uniformity but is very deceptive. A small proportion of the pupils most responsive try to answer as they think the teacher wishes, and a large proportion wait to hear what the others say and try to remember that. The questions are in a way answered by observations of the specimens in hand, but the "leading" process is so powerful that practically it amounts to indirect telling. Information much disguised is the staple material of the lesson, although it is not intended, and the giving of it is simply transferred from the teacher to a few responsive pupils. As a whole the pupils do not "take hold," and the disposition to make independent investigations is not cultivated.

A principal of a training school on hearing such a lesson comments thus: "This brought us to the end of a *very logical lesson*, but one which was at the same time one of the most mechanical, most wooden, most stupid and profitless lessons to which I ever listened. It was all right according to the letter of the law, but where was the spirit of education? I need not tell you of the unrest, the inattention, the new channels of activity that the children opened up for themselves, the imitation, the lack of spontaneity, the utter inability to hold the mind to this dreary treadmill."

Isolation tends to exaggerate variation. The normal school has not been connected with the scientific school, and neither has been closely connected with the elementary schools. Only within a very few years have city normal pupils had somewhat regular practice in teaching in elementary schools; and even now the practice must be very limited in city schools, since the latter must do regular and efficient work and not be interfered with much by novices in teaching. Pupils of the scientific schools have not had the meager opportunities for teaching which have been furnished normal pupils. If they attempt to teach science in elementary schools, they are obliged to experiment with children, not only to find out what the children are prepared to do, but what they themselves can and can not do; and their experiences, as well as those of their pupils, are full of surprises and disappointments. Some graduates of scientific schools take charge of the science work in normal schools, whose special work is to instruct teachers in natural methods. It is fair to ask whether such graduates, who have the opportunity of influencing so many teachers, are helping or hindering the cause of elementary science. Neither the normal schools nor the scientific schools, although they differ widely in methods and seldom touch common ground, consider the possibility of graduating pupils who are more than likely to prove unscientific teachers of elementary science.

The correlation of the normal school, the scientific school, and the elementary school, practically carried out, would give us a

fair prospect of discovering the true scientific method in teaching children.

I have seen an elementary school of some six hundred pupils, in which teachers and pupils follow closely the scientific spirit, if not the very letter, so far as it should be followed by children varying from five to fifteen years of age. All do the same kind of work, which is allowed to vary in quantity and quality in accordance with the natural ability, individuality, and originality of each pupil. Local material almost exclusively is examined individually, each pupil thinking and passing judgment for himself, and expressing his ideas accordingly in writing and drawing. The disposition to attack, to take hold, to investigate, and to make careful records of his own ideas and discoveries is cultivated studiously by keeping the pupil in the foreground and the teacher in the background. The prominent instructor, questioner, talker, gives place to the quiet director, inconspicuous but working with the effectiveness that characterizes the silent forces of Nature. The work is entirely independent of the normal school and the scientific school, but it is suitable, plastic, and power-giving.

A brief mention of some of the materials used in the work and a description of how they are used may serve to show whether the work is worth doing.

Each pupil is supplied with a specimen (all the specimens being of the same kind), such as can be found in the neighborhood —a leaf, a vegetable root, a nut, an insect, a rock, a flower, etc.— which he examines carefully, draws, and describes in writing, according to a very simple plan consisting of four or five words written on the blackboard. The words indicate the order of the work and the paragraphs of the description. The pupil is let entirely alone until he has done all he can do.

To draw his specimen he looks at it one way and gets one good presentation and impression; to describe it he examines it in a different way and gets another good presentation and impression —a process that holds him to his work without his being told what to look at, what to draw, and what to describe. He helps himself, and soon forms and fixes the habits of application and self-reliance. His work shows his teacher exactly where he is in drawing and descriptive work. Constantly judging of proportions, especially those of irregular objects, he soon learns to grasp the proportions of various forms quickly and to represent them with such facility and accuracy as to surprise teachers who have carried out only the regulation course in drawing. Many pupils can draw natural objects much more satisfactorily than they can describe them in words, and that, too, without formal instruction.

The ordinary courses of instruction in drawing, treating almost exclusively of artificial and symmetrical forms, have not

helped children to draw the natural objects which they study to any great extent, but often have hindered them by taking all their drawing time for dogmatic instruction in mechanical drawing, historic ornament, geometric solids, and regular, symmetrical objects generally. No instruction in natural history work can be called scientific that fails to develop the pupil's power to draw what he examines. Darwin said that a great amount of his otherwise valuable manuscripts became useless on account of his lack of ability to draw.

The part that language takes in the plan should now receive brief consideration. The pupil, being accustomed, from the time he begins to write sentences, to describe in writing what he himself sees, recognizes the connection between his ideas and their signs on paper; his facility in expressing his ideas more and more correctly increases; and when his work is criticised, he is in the proper mental attitude to receive and assimilate the criticism. By examining the pupil's work after his first essay on a new subject the teacher gets at the defects in the pupil's vocabulary at once, and sees just where to help him. In no other way can the teacher reach that point so soon. Since the pupil is left to himself, he must describe his object in his own words, and he will not use any that he does not understand; if those are wrong in form, he can remember the corrected form easily; but if new words, which he does not understand, are given to him, he remembers their correct form with difficulty.

The teacher helps at the right time when the pupils need help. He examines their papers to discover excellences and errors in regard to matters of fact and forms of expression, gives class instruction at the blackboard on the prevailing errors, makes illustrative sketches, rubs out all illustrative work at last, and directs the pupils to redraw and redescribe the objects previously studied, confining their work closely to what they see in their specimens.

Up to this point all information not obvious in the specimens is rigorously excluded. Information must be divorced from observation. No other course can be followed safely by the rank and file of teachers. The pupils, having had the opportunities required for observing, thinking, and recording for themselves, and a substantial basis for information having been thus laid, individual experiences, readings from books, and reasons, causes, and results are considered, and the whole, observation and information, is incorporated into a composition most carefully written during the time devoted to language work. The power thus developed in the lower grades enables pupils of the higher grades to stop with first drafts.

Again, Darwin confesses that he was much hampered by his

lack of facility in expressing his ideas. In his youth he had no training worth naming in drawing or in written description. To know and not to know how to express what is known is questionable science. The true scientific method must include adequate expression.

As a rule, such objects are selected for study as will serve for a good drawing (thirty-six rocks and minerals excepted)—shells, crystals, leaves, seeds, seed-vessels, flowers, ferns, mosses, and insects—including butterflies, moths, crickets, grasshoppers, locusts, flies, dragon flies, beetles, bees, wasps, and hornets—each kind being sufficient in number to supply each pupil with a specimen. Butterflies emerge from chrysalids and moths from cocoons discovered and brought in by the pupils, who draw and describe the various stages of these insect metamorphoses as they see them going on. They have studied in the same way seedlings in successive stages of growth—corn, squash, maple, acorn, etc.—each pupil having his own marked pot.

The school garden contains much available material—many varieties of wild asters and golden-rods, spring flowers, fall flowers, wild and cultivated, vegetable roots, small patches of wheat, rye, oats, barley, and buckwheat, cucurbitaceous plants, corms, tubers, bulbs, and ferns. The pupils cultivate the plants, and compare, draw, and describe the varieties from notes taken on the ground.

Once a year, on "public day" in May, the pupils bring in for exhibition their collections of minerals, rocks, shells, woods, insects, and pressed plants—usually from five to six thousand specimens which change from year to year. All the specimens are labeled carefully, classified, and arranged in the large hall on long tables covered with white paper. The best collections have a printed card label accompanying each specimen.

The work done outside of school in getting these collections together is of great educational value and the natural result of a method suited to the child's condition. It runs neither into haphazard channels nor into cast-iron molds. The child, rather than the subject matter, is the focusing point. The principal things sought are the science of his interests and habits of work, and the development of his powers of observation, expression, and self-reliance.

Many schools in various parts of our country are doing similar work, and in the summaries of such work made accessible to educators we shall soonest discover a scientific method thoroughly suited to the needs of elementary schools. Colleges and scientific schools have not the points of vantage to make the discovery.

NATURE AT SEA.

By FRANCIS H. HERRICK,
PROFESSOR OF BIOLOGY IN ADELBERT COLLEGE.

IN crossing the seas, as in walking through the fields, there is always the anticipation of making some new discovery. To-day Nature may reveal to us some long-withheld secret. This illusive bird or wild flower which we hitherto missed we now meet face to face. So it is in traversing the great blue fields of the ocean. On this voyage hardly a living object may be seen. The sea-serpent lies low. The captain complains of meeting few sail. Again, on the same track, the winds are fair, the ship makes her course, and the storm cloud no longer baffles the navigator. The inhabitants of the sea show themselves at the surface, and the long days lose their monotony. The voyage is a memorable one in the sailor's calendar.

A good traveler and genuine lover of Nature has the advantage often of turning the rubbish heaps of another to the best account. He finds gold where his companion sees only sand. We can hardly imagine Agassiz or Thoreau (the one representing the scientific, the other the poetic naturalist) at a loss to turn Nature to account anywhere under the sun. Thoreau delves in his Concord meadow and brings up some precious nugget, while Agassiz studies the waterworn pebbles and finds them more interesting than arrowheads. Yet our good observer is, no doubt, put to a severe test at sea, where he may often have occasion to repeat with feeling those familiar lines:

> "Day after day, day after day,
> We stuck, nor breath nor motion;
> As idle as a painted ship
> Upon a painted ocean."

I left Nassau, New Providence, the 1st of July, on a sailing vessel bound for New York. Our boat was a trim schooner of a hundred and fifty tons burden, clean and well ordered, and did credit to this kind of craft. We sailed out of the harbor and crossed the coral bar at high water under a steady southwest breeze which soon drove us out of sight of land and wafted us many miles away in the night.

The Bahaman capital shows to best advantage from the water. Its peak-roofed, chimneyless houses and stuccoed walls of coral stone make a strong contrast with their deep green setting of tropical foliage, the ever-encroaching bush which comes up to the threshold of the town on all sides, and covers these rocky islands with a perpetual mantle of vivid green. The impenetrable maze

of the fig and silk-cotton trees, and the looser, stiffer foliage of the almond, add here and there a bolder touch to the landscape, and the unmistakable cocoa palms, seen from afar, adorn the hillside or wave their feathered crests above the beach.

The town skirts the shore for some distance, covering the slope of a low ridge which lies parallel with it. From the brow of the hill an old fort looks down upon the clustering roofs below, upon the white streets, and the dazzling bluish-emerald waters of the bay. A remote fortress half hidden by mantling shrubbery stands guard on a low bluff to the right, while cottages and fishermen's huts, following the main street eastward, dot the shore for several miles on the opposite side. This picturesque little harbor has a livelier appearance to-day than usual. Dingy sponging boats and leaky-looking fishing craft lie along the wharf and down the bay, or are beached at low tide. There are larger vessels bringing ice from Maine, and the iron-gray sides of an English steamer loom

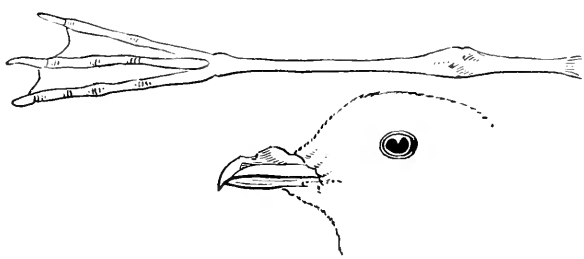


Fig. 1.—Head and Foot of Wilson's Stormy Petrel.

up from yonder low dock, where it now discharges its merchandise fresh from over the sea.

Sailing northeastward, Nassau and its shipping are soon obscured by the long green bar of Hog Island. This is in turn overlapped by similar keys, which gradually fade to green lines and dip under the waves.

For several days the ship speeds on with every sail set. Day and night not a sound is heard but the rustle of waves and the occasional flapping of a sail or sharp report of a rope on the taut canvas. On the sixth day out the sea was nearly calm, like glass, heaving in long, subdued billows, or like a silvered mirror, with slow, undulating tremors spreading far out to the horizon edge.

We noticed that the petrels now rested for the first time on the water after their long journey by wing. These little waifs appear never to alight except in calm weather. Day after day they follow the vessel in search of the stray scraps of greasy food thrown overboard. Now they flit noiselessly alongside, then dash on ahead or fall back astern, and so over the same course again hour

after hour for days at a time, without uttering a note or showing the least sign of fatigue.

Dauntless, brave-hearted little bird!—bred in the storm and passing thy life on the ocean wastes. How nimbly you trip along the surging waves, now hid in their deep valleys, or skimming their crests, which you pat with your slender webbed feet, as if to caress them when ready to ingulf you!

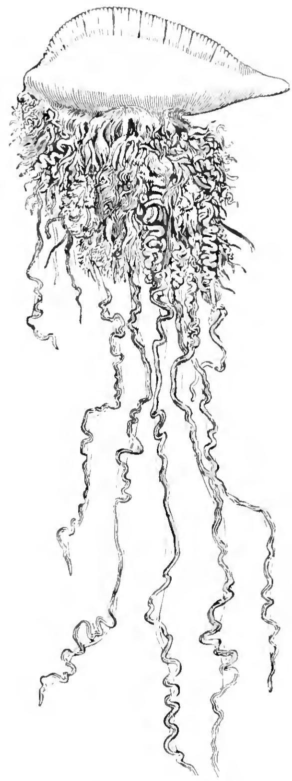


FIG. 2.—PORTUGUESE MAN-OF-WAR.

We had not been at sea long before these petrels found us out, and they followed us hundreds of miles. At night I heard, or thought I heard, low, crooning notes from them, but was not sure this mournful sound did not come from some part of the ship's rigging. This is Wilson's petrel (*Oceanites oceanicus*), named in honor of that great lover of the birds, and well described by him in his American Ornithology. Wilson had an opportunity to study this species while coming by sailing vessel from New Orleans to New York. In order to examine them more particularly he shot a number, notwithstanding the superstitions of the sailors, who lowered a boat and helped him pick them up. These genii of the storm remind you of the swallow, whose graceful movement and power of wing they have, but, unlike the latter, they never soar above the turmoil of the sea. Their plumage is of a nearly uniform sooty-brown hue, excepting the tail coverts, or feathers at the base of the tail, which are snow-white. The physiognomy of the bird is marked by the beak, which points downward, thus enabling it to pick up objects with greater ease from the surface of the water. These delicate, soft-plumaged creatures are the scavengers of the sea. Toss out a few scraps of food, and the object of their comradeship is at once seen. Immediately their quick sense detects it, and all from far and near collect about the floating object, making a little dark cluster on the water. In thus taking their food they never alight, but hover over it, standing tiptoe on the wave or lifting their delicate black feet up and down as if dancing on the water. From this characteristic performance the name *petrel* is said to be derived from Saint Peter, in allusion to the story of his walking on the sea.

This and the rarer stormy petrel and a third species, which all resemble one another very closely, are commonly known to sailors as "Mother Carey's chickens," a name quite generally applied to this family, and probably suggested, as Wilson observes, by their mysterious appearance before and during storms, their great power of flight, and obscure habits. The superstitious mariner may indeed have regarded his little comrades not as harbingers merely, but as agents in league with the powers of darkness, directly concerned in bringing the storm. Mother Carey is the *mater cara*; so with the French these birds are "*oiseaux de Notre Dame.*" The gigantic fulmar of the Pacific is known as "Mother Carey's goose," and hence the phrase "Mother Carey is plucking her goose"—that is, "it is snowing."

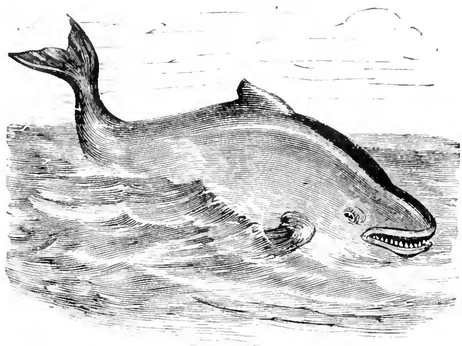


FIG. 3.—COMMON PORPOISE.

While the petrels do not "carry their eggs under their wings and hatch them while resting on the sea," as seafaring men affirmed, yet their domestic life seems to be curtailed as much as possible. They nest in cavities in rocks along the coast or in burrows in the ground, laying a single white egg. This species is said to breed in Florida and the West India islands.

The petrel belongs to the wild wastes of the sea, as the gull belongs to the shore, and the swallow to inland districts. Sea birds are as completely helpless when driven far inland as the strictly land species are at sea. Every now and then we hear of some wanderer from the coast being picked up half dead from exhaustion and fright hundreds of miles from the ocean, having been shipwrecked apparently and blown in thither during a storm. A case of this kind was communicated to me some time ago by a gentleman in Sharon, Vermont, where a specimen of the dovekie, or sea dove, a common bird of the northern New England coast, was found one morning in the fall on a neighbor's porch.

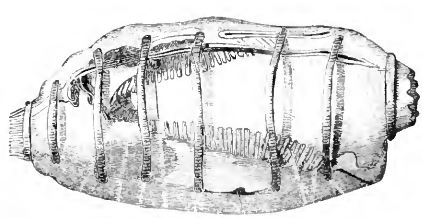


FIG. 4.—SALPA.

The helplessness of our song birds when carried to sea is piti-

able in the extreme. I rarely make a voyage of any length but some small bird is shaken out of a sail where it hid in its fright, or is found taking refuge in the rigging. Once, while off Cape Hatteras, a finch or sparrow of some species came aboard our schooner, showing great fatigue and fear by its tremulous, hesitating flight. Its small wings were of little avail to cope with the wide blue expanse on which distance is so deceptive. It fluttered about from rope to spar, glad to find "rest for the sole of its foot," and although it made short detours—reconnoitring sallies now and then from the boat—I think it invariably returned, and decided to take passage with us to the land.

On a calm evening I saw another larger bird looking like a petrel, swimming about with Mother Carey's chickens. It had long, swordlike wings, and was of a dark slate color above and below pure white. Once a pair of tropic birds crossed our track. We frequently catch glimpses of the bold shearwaters skimming the distant seas, and hear their piercing cries as they dart along the waves, now lost in the trough of the sea or soaring aloft, their breasts white as the foam below.

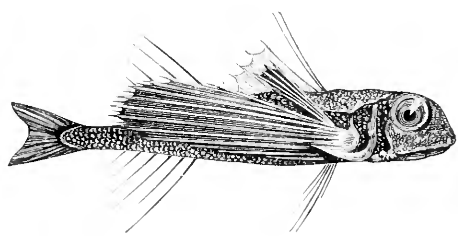


Fig. 5.—Flying Gurnard.

How welcome is every unusual sight and sign of life on the desert sea plains! The great schools of fish ruffling the surface, now and then leaping into full view; the sleek porpoises showing their powerful tails or racing the ship under her bows; the chance shark which dogs the vessel; the splendid physalias, or Portuguese men-of-war. How eagerly the sailor scans the horizon to catch a glimpse of a sail, and the discovery is soon known to every one on board! A mere phantom to an ordinary eye, he tells whether it be schooner, bark, or brig, knows her course, perhaps also where she is bound and what she carries. Now we see the topmasts only of some vessel standing off on the horizon, or the gray form of a ship half screened by the fog. Now a steamer passes us, and the thud of the wheel and clang of its foghorn are heard long after it vanishes in the mist.

I never saw the physalia so abundant as on one afternoon of this voyage. The surface of the sea heaved in long, gentle swells. At times a dozen of these little sails could be counted from the vessel. Those farthest away appear as white, glistening specks. One, unusually large and handsome, floats near by. It looks like a diminutive boat blown out of iridescent glass. Its transparent, gleaming sail, gathered at the edge, is tinged with pink and blue

next the water. Once we dipped one in a net, and placing it carefully in a pail of sea-water, examined it at our leisure on deck. It was then seen to consist of a float or air bag, and thick clusters of pink bodies attached, and longer blue ones which extend down in the water.

Our little man-of-war bears a truer resemblance to a well manned and ordered warship than might at first be supposed, since it is not an individual, but a community of polyp-like ani-

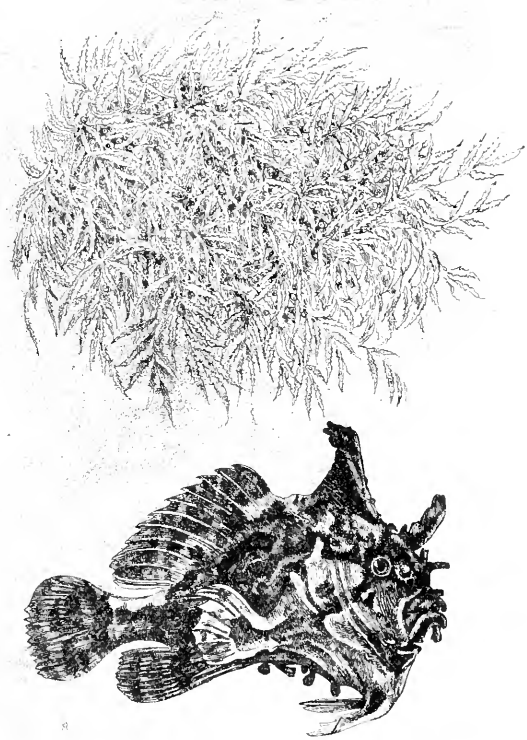


Fig. 6.—Antennarius.

mals bound together for common support and protection, with a division of labor recalling that maintained aboard a vessel, or, better still, like that seen in a hive of bees. There are four kinds or grades of persons in the physalia community. There are the *feeders*, the pink bodies just mentioned, which procure and digest the food for the whole community, all the polyps communicating freely with each other; the *defenders*, the long, indigo-colored tentacles, which may be distended like flexible threads to the

length of several yards, and which are covered all over with batteries of poison cells, a touch from which is like the sting of a dozen nettles; the *reproducers* are the very small polyps at the bases of the tentacles; while the locomotor *float* represents a polyp or hydra which has become modified the most of all. This float, like a miniature sail, may be raised or reefed by admitting or expelling the air, and if punctured it collapses like a toy balloon.

The physalias are hydrozoa—that is to say, they belong to that large class of marine forms which include, with the little

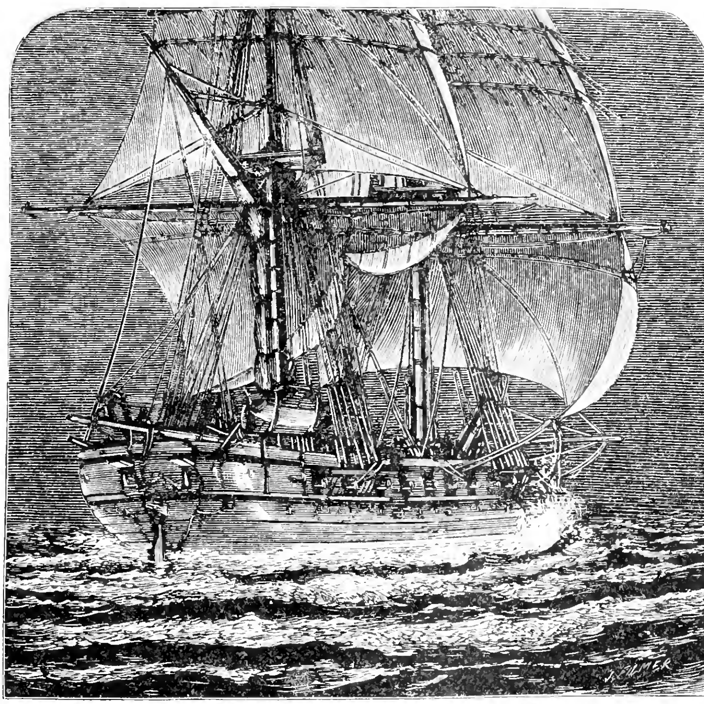


FIG. 7.—SHIP IN PHOSPHORESCENT WATERS.

green and brown hydras of fresh-water ponds, the highly colored or glass-like jellyfish or medusæ, and those numerous hydroid colonies or branching stocks which often remind one more of small shrubs or some vegetable growth than of a community of animals. Many hydrozoa possess marvelously complicated life histories. By "alternation of generations"—that is, by the regular alternation of a *sexual* generation with one or more generations reproducing *asexually* by budding or division—and by division of labor, an almost unlimited number of individuals with various functions, as we saw in physalia, may arise from a single polyp egg.

Porpoises bent upon voyages of their own pass us at intervals. At each turn in the water we see their huge fins and shining, convex bodies. The porpoise describes a graceful, undulatory line in its course through the water; now appearing at the surface and immediately diving below it, showing itself only as it rounds the crest of each wave. When a number rise together in line, their dorsal fins and backs alone being visible, you are reminded of a great saw with huge, incurved teeth. Here, again, are others apparently at play. How they lash the water into spray with their powerful tails! Now one shoots like an arrow into the air; another jumps, and clearing the water for several feet, enters it again with a plunge. This may be anything but play, however. A whale or some other enemy is perhaps giving them chase, and they are fleeing for their lives.

We saw several whales during this voyage, and on one evening two crossed our bows. They swam side by side, rolling along at an easy gait, much like that of the porpoise, and spouting a jet of spray as they came to the surface to breathe.

At another time a very large school of porpoises was seen advancing toward our vessel. There must have been several hundred of them. They formed a long, not very deep line, swimming in several squads of fifty or more each, and crossed our course without altering theirs. Some passed by the stem or bow, or with a plunge shot under the vessel as if it were a plank. Both dolphins and porpoises like to race with a ship, although it costs many their lives. You can see their brown, spotted bodies and blunt noses as with great speed they shoot to this and that side of the cutwater. The faster the ship goes the greater seems to be the sport. The porpoise is little more than a powerfully muscular tail, developed at the expense of the rest of the body. Most sailing craft carry a spear or harpoon, for the sailors not only like the excitement of taking these animals, but also find in their flesh a welcome variety to the monotonous ship fare.

One morning, as I stood with the captain on the forecastle deck, he attaching his harpoon line as I watched the porpoises, I saw a large loggerhead turtle under the bow, his brown back being barely under water. He appeared to be asleep, but in a moment the vessel struck him, and down he slowly paddled out of sight. The spear did not happen to be in readiness, so that our turtle soup that day was a strictly Barmecide dish.

The number of small invertebrate animals which come to the surface on calm evenings is quite astonishing. Once in May, while in the vicinity of the Gulf Stream, near the Florida coast, there appeared regularly at about four o'clock in the afternoon countless swarms of a brown jellyfish or medusa—"sea thimbles," as sailors call all animals of this class—and this species (*Linerges*)

is about the size of a thimble. The clear indigo water was speckled with them. You could dip them up anywhere in a bucket, and we sailed miles without noticing any appreciable diminution in their numbers. This and like spectacles give us a

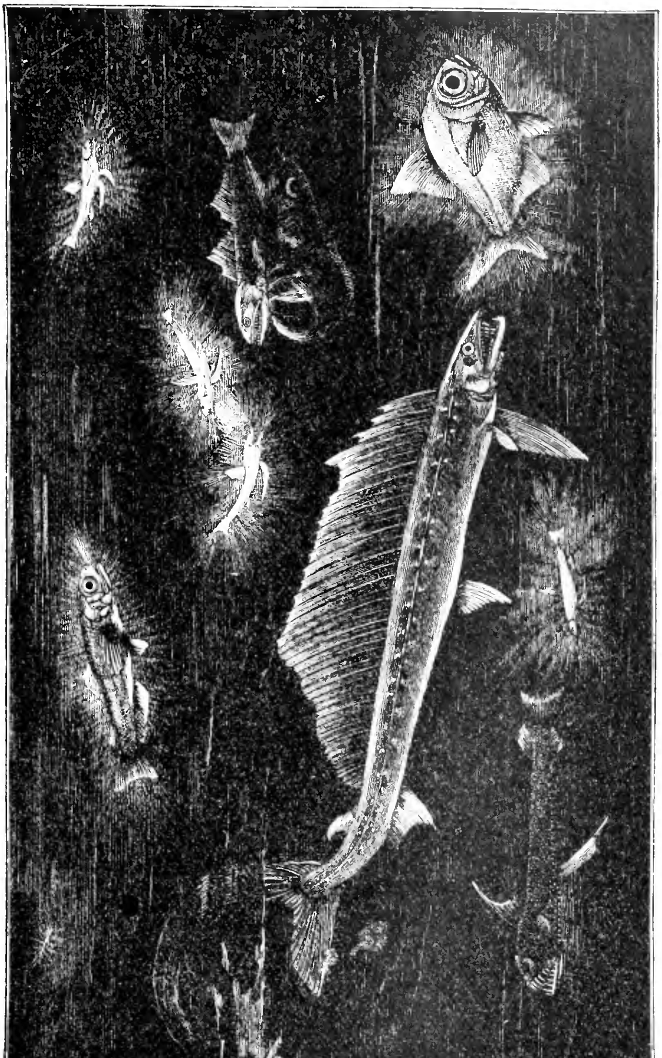


FIG. 8.—LUMINOUS FISHES.

faint conception of the incalculable wealth of the sea in living things, and of their superabundance if allowed to multiply unchecked.

Another marine organism seen floating near the surface is three or four inches long and looks like a little roll of white lace with a pink spot in the center. This is a species of salpa, which

belongs to the class of Ascidians, and is especially noteworthy since its embryonic history bears a strong resemblance to that of the lower vertebrates. The life history of the salpas is greatly complicated by the process of alternation of generations seen in physalia, and it was in them, in fact, that this phenomenon was first noticed.

The flight of the flying fish recalls that of some insects. When a ship plows through a school of these creatures, how they scud off on all sides like grasshoppers rising from underfoot in the fields, and by the aid of their gauze wings, the pectoral and ventral fins, fly to a place of safety! From the indistinct halo seen about these fish in flight, from the abrupt turns which they execute, going as readily against the wind as with it, and from their apparently uniform speed, we naturally infer a rapid beating of those delicate wings, as in the case of humming birds and certain insects, and this inference is probably a correct one. Many observers, however, contend that this is not a genuine flight, but scaling. According to this view, the fish project themselves with a great velocity from the water, press with their wings, held at an advantageous angle, against the air, and are thus kept up, while they are carried forward by their own inertia. Their motion would thus be gradually retarded until they finally entered the water again, like that of a stone skimmed along the surface of a pond, while on the contrary their flight appears to be quite uniform. This and other mechanical difficulties, and the fact that the beating of the fins can be clearly seen in other species of flying fish, show that the common belief that these animals *fly* in the strict sense of the word is probably the true one.

The vegetation of the sea is limited to the brown masses of sargassum or "gulf weed," which is most abundant in or along the borders of the Gulf Stream and may be seen growing on the sheltered reefs about Nassau. This alga is especially interesting for the wealth of marine life which it shelters. A large mass, which has been a floating island for some time, possesses in fact quite a varied fauna. If you fish up a handful of it and shake it over the deck, the little animals pour down like rain. Here are crabs and shrimps without number, some of them very delicate, no longer than a pin; barnacles, mollusks, and fish of several species, one of which, the *Antennarius*, regularly lives and builds its nest in these little islands. This grotesque fish is two or three inches long and nearly as broad in a vertical plane, and is variously spotted and mottled with light and dark-brown colors. Its lower fins resemble a pair of hands in shape and function, and its head recalls that of a mediæval war horse armed and plumed.

These little communities furnish a striking instance of the protective coloring of animals, a phenomenon of which there

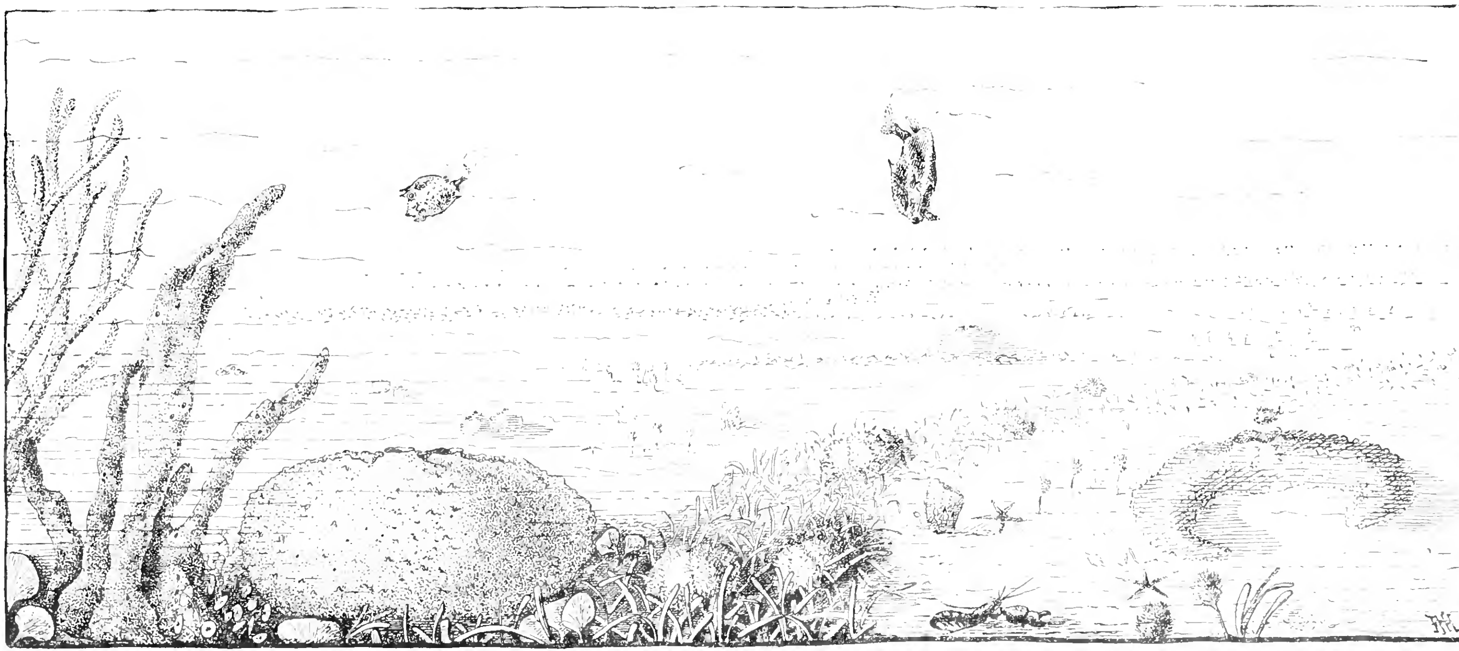


Fig. 9.—A Submarine View of the Shore at Nassau. A sand bottom near a sheltered reef with loggerhead sponges (*Hircinia arcuta*) in the foreground, and buds of seaweed, sprinkled with large white "sea eggs" or sea urchins (*Hipponœ*). Trunkfish (*Ostracion*) are swimming above.

seem to be nearly as many examples as there are living things. The general cast of the plant and animals inhabiting it is a dull brown. The goose barnacles, which are attached to the sprays in great numbers, have white shell-cases with brown stalks. The crabs are brown with usually a large white spot on their backs, apparently in imitation of the barnacles, while many of the little shrimps are marked in the same way. The spherical floats of the sargassum are, furthermore, incrusted with the white lacelike skeletons of bryozoa. The brown gulf weed is thus dappled with white, and it is evidently advantageous for animals living in it to simulate its colors, which they do in an extraordinary manner. These colors are certainly protective, and if produced by the slow process of natural selection, by which the hue of the organism comes to harmonize with that of its environment, to the evident advantage of the former, we must imagine this species of alga to have floated about with these and similar animals for long ages.

The salpas and medusæ are beautifully phosphorescent at night, and in fact most of the invertebrate life of the sea, which on calm evenings swarms in myriads at the surface, possesses this remarkable power. Then is every ripple followed by a train of glowing sparks, every wave which breaks against the ship by a brilliant meteoric shower. The larger medusæ, which look like softly glowing balls of mystic fire, and the barrel-shaped ctenophores are stars of the first magnitude, while behind there is a whole galaxy of lesser lights, to count which would be much like counting the stars. As I sat one evening watching our rudder, after which trailed a long, curling line of sparks, four small fish made their appearance and swam by the stern for several hours. Their forms were illumined in the black water, and a train of fire followed each as like little meteors they darted after the ship.

We can form at most but a very imperfect idea of the life of the sea from the chance glimpses afforded on the most favorable voyage. We see but transient tokens of that vast life which the sea holds in her teeming bosom.

Could we project vertical sections of the ocean upon a screen and examine these pictures in detail, what revelations might they not unfold! We would have the dwellers in every story of the sea caught in their natural attitudes, the hosts of smaller animals at the surface, the many fish and other monsters of the deep, and those far off dwellers in the abyssal sea. Scientific study with the microscope, the tow-net, and deep-sea dredge is revealing little by little those wonderful forms of life which have been so long hidden from human eyes.

NORTH AND SOUTH AMERICAN ABORIGINAL NAMES.

By M. V. MOORE.

THERE are numerous evidences showing that the same aboriginal peoples who named the waters of North America coined also the prehistoric geographical titles in South America. Scores of actual identities are revealed in the prehistoric nomenclatures of the two portions of this continent. These identities are not only in various terms that appear in the river names which still survive and betray the tongue of indeterminate ages here, but the very same ancient words in full are apparently reproduced in many instances. The reproductions are indeed of such a character as to induce the belief that the earliest civilization of both North and South America had origin in one common ancestry. The oldest nomenclature surviving in the countries both North and South certainly indicates origin in civilization.

We have now no definite knowledge as to how some of the old aboriginal names should be properly written in our English idiom. There are slightly different versions or expressions of the ancient words which have been perpetuated in the idioms of the French, Spanish, and Portuguese—words that are evidently the same thing in remotest origin and structure. From the very beginning of the modern European conquest and colonization, the "Indian" names have been invested chiefly with what is purely a fanciful and conjectural orthography in their English writings. There has been no surviving testimonial, in either living or dead tongues, fixing the definite expression of the ancient words just as the native man would have written them had he been possessed of the proper facilities.

Sometimes the old native names have been made to appear unnecessarily grotesque in their writing—in some instances as much so as the rude savage himself appears personally—the fact illustrated in the writing *Youghiogheney* for simply Ya-og-ha-na, and in *Esquemeaux* for Es-ka-mo. Many purely poetic garbs of the old words have become incorporated into our permanent geographical literature. The names Mississippi and Tennessee are examples of the fanciful versions of the old aboriginal titles: the former is supposed to have been in sounds represented by the English writing *Mes-sis-a-pa,* while the oldest historic records extant showing the latter give the writing as *Ten-as-sa.* What is evidently one ancestral word appears in the modern versions of *Shewanee, Sewanee, Suwanee, Swanan,* and *Chowan.* The French writing *Cheyenne* is the same word in the remote ancestry, as is now believed.

There is a South American river name written in our English idiom *Amaccura*. In Florida we have the old aboriginal title *Amaxura*. No man is now learned enough to maintain, with any assurance of truth or authority in his favor, that from either standpoint, historical or etymological, there is any real or essential difference in the two names.

The same thing may be said of two other well-known ancient "Indian" appellations—*Orinoco* and *Oronoko*, as they are now written in our English versions. The former is a native South American word, while the latter—*Oronoko*—is unquestionably an aboriginal North American river name. A corruption of the ancient name has been applied, as the permanent modern title of the stream, in the word written *Roanoke*, the old initial vowel sound in *o* finally dropped. Our wisest philologists are unable to determine any difference in the true etymology of the two writings, *Orinoco* and *Oronoko*.

Nor can they perceive the real difference—for none exists—in the Carolina river name *Occonee* and the South American appellation written *Ocona*. We have in North America the name *Pawnee*; in South America they have what is doubtless the very same thing in the writing *Pana* (Pawna). We have in New England the native name *Chicopee*; South America has *Chicapa*. (Our authorities tell us that "oopee," "upa," "opee," "ippe," "epe," "apa," etc., are simply dialectic expressions showing one common ancestry—each being a term for water or river in the native tongues of the continent.) We have *Omaha*; South America has *Omagha*. We have *Aboite*; South America has *Abaite*. We have in South Carolina the river name *Saluda*; South America has the *Salado-rio*, the Sal-aw-dow River. We have *Tygar* River; South America has *Tigri*. (The Old World has the name written in English *Tigris*—really *Te-ga-ri*, or the *De-ka-li* of the Hebrew; all three of the names—*Tygar*, *Tigri*, and *Tigris*—showing a common though very remote ancestry.)

Chico and *Chota* are found in native names in both North and South America. We have *Choco* and *Choccolocco*; while South America has *Choco-loochee*. "Loochees" and "oochees," or "uchas," without number, are found all over the continent, North as well as South, in the native names of waters. In South America are several *Ubas*, ancient appellations of waters. California has two rivers, the prehistoric Indian names, written *Yuba*. There are scores of "oobas" and "ubas" in the ancient names of waters of the continent both North and South. And what is a more startling feature of the prehistoric speech of the New World is the fact that this same word, or the sounds heard in the writing "uba" or "yuba," is found in the prehistoric water nomenclature of various peoples of the Old World.

South America has *Pachitae;* Georgia has *Pachita.* Brazil has *Paculi,* or *Pacoolee;* South Carolina has *Pacola,* or, as it is written in the old French idiom, *Pacolet,* the final letter silent. Illinois has *Peoria,* an ancient Indian name of a lake; South America has *Piura* and *Peru;* while Louisiana has the bayou name *Pero,* the French idiom rendering the old word as *Perot.*

It is scarcely reasonable to conclude that all these—and many more that are known to exist in the way of coincidences, identities, and similarities in the prehistoric water nomenclature of the continent—are the result of mere accident, or in conformity to any universal lingual law. The vast array of actual correspondences can be accounted for reasonably or properly only on the theory or hypothesis that one common ancestral tongue was known and understood by the race of peoples who overran and colonized the continent in the remote indeterminate past—a race of peoples who so fixed their speech in the river names of the Western world that the words have survived through all the mutations of governments, and through all the changes incident to the human tongue in the countless ages that have intervened since the beginning when the words were first applied here to the waters. It is a very singular and striking fact in human history that the names of rivers or other waters have outlived all other evidences of the prehistoric human speech. There are yet in existence the names of the waters of the very primitive home of man itself, when all other evidences of the Adamic age and tongue have been swept into utter oblivion. We know that the names of most of the waters of the Old World have origin in indeterminate eras: the old word-landmarks have been preserved and perpetuated through the countless changes in nations and tongues since, with no other variations save those incident to the different idioms in the old and the new, our word Nile being the English idiom rendering the Latin *Nilus* and the Sanskrit *Nali.* Rhine is the English of the old *Rhenus* or the older *Rina.* The ancestral germs in the respective words are easily determined and read in each idiomatic expression.

We find in great frequency in the prehistoric river names of both North and South America a word or term that is variously written in our geographical literature as *augua, agua, aqua, auqua, ogga, occa,* and otherwise. Many of the old names have come to us through the early Spanish records, these showing in most instances the Spanish form or idiom in writing the (Spanish) term or word for water or river, *augua.* But we can not believe, with reason in our favor, that wherever the term appears in the writing of the prehistoric names its presence is wholly due to the Spanish influence on the continent. The term occurs in native names in localities where there is no evidence showing that the

Spanish influence was ever felt there. It is found also in sections where the Spaniard did not remain long enough to permanently inject his term *agua*, or *augua*, into the dialects of the aborigines. Indeed, no native tribes or peoples have been known on the continent who have readily adopted the tongue or even the general terms of a foreign race. Even the modern Indians have persistently rejected the tongue of the European.

And yet we have such South and Central American names as the following—titles that are regarded as native or aboriginal—in the modern writings: *Ur-augua, Par-augua, Agua-pi, Nicaragua, Conch-augua, Des-augua-dero;* these and many more showing the same term that is conspicuous in our native Indian appellations, written *Wat-auga, Chicam-auga, Canadian-augua, Nottas-augua, Aut-augua,* and the like, in North America—words that are quite universally regarded as pure aboriginal names, the main term entirely free from the influences of the Caucasian tongue.

IMMATERIAL SCIENCE.

By E. S. MOSER.

THE Material View of Life and its Relations to the Spiritual, by Prof. Graham Lusk, Assistant Professor of Physiology, Yale Medical School, in The Popular Science Monthly for August, 1893, presents to the mind of a layman a unique combination of facts and fancies, of scientific deductions and metaphysical assumptions. The professor's "material view" in the main finds adequate support in the domain of demonstrable knowledge, but his "reasoning" process in support of his spiritual view is distributed over a good deal of imaginative and unknown territory. The professor observes: "Matter is divided into ponderable and imponderable—ponderable, that which can be weighed; imponderable, that which can not be weighed." Some proof is certainly required in support of this statement. The conventional terms of speech employed in treating of matter admit of a division of matter within certain limitations, to more clearly establish the differences in material forms; but to boldly imply that a portion of the matter in existence has no weight—is imponderable—is to challenge the presentation of clearly defined evidence. The professor may be right, he may be wrong. He may believe he is right, yet belief in the absence of knowledge is *mere belief*, and one belief in the abstract is of about as much importance as any other belief, however ridiculous. Moreover, to assume to establish the existence of an "ether" as a means of explaining "something otherwise inexplicable," is a process of reasoning which

may pass at par with very learned metaphysicians, but it can hardly claim the serious attention of thinking minds, *particularly* when the "something otherwise inexplicable" is something the existence of which is taken for granted. The professor continues his process of reasoning: "A man dies; the spirit passes from him; the flesh is left." The synthetical activities of the body which produced the phenomena of life have ceased; the analytical or destructive process is master of the situation; but "the spirit passes from him"! *What* passes from him? What is this *spirit*, professor? "Imponderable spirit" is it? I don't understand you, because I do not know what you are talking about. You may explain that the spirit is ethereal matter. Will I be informed as to what spirit may be or is, when I know nothing about imponderable matter? "And likewise may there not be a spiritual ether surrounding us, a medium through which impulses may come to the spirit from on high, and from the spirit be transmitted to the intellect? Such influences come to us strongly at times, as at the communion table." This may be so, but even your single illustration, as to causation, lacks confirmation. We have observed so-called evidences of "the spirit from on high" in the prostrate forms of persons at sacred altars, persons in a state of unconsciousness produced by brain acting upon brain. I know, if I know anything, that a certain amount of physical energy is involved in every instance of nervous excitation, and that the influence of this energy acting upon *matter* is easily communicated to, and will act upon, willing subjects. Still further: "Now, is it not conceivable that, in the spirit after its severance from the flesh, our present imperfect senses may become perfect, and the influence of other now unthought-of sensations become possible?" No, it is not conceivable, if the conception is to rest upon a rational basis—truths at this time demonstrable. The existence of "unthought-of sensations" is a bold assumption. The conception is not scientific, because our present "imperfect senses" are the outcome of purely physical (earthly) conditions, so far as science knows anything about the senses. What science does not know, or what science may know hereafter, has nothing to do and can have nothing to do with the professor's conception at present.

I concede to every man the right to formulate a belief that will afford him some needed consolation in his struggle for existence, so long as he is perfectly willing to allow other men to do likewise without let or hindrance, but no belief should be set forth in the name of science unless there be tangible evidence produced in support of it.

It is frequently observed that some scientists are loath to accept and to abide by the results obtained as the fruitage of their laborious investigations. They observe the operations of Nature,

closely study causes and effects, discern principles of action, and thereupon formulate truths. Forthwith these truths must be utilized to bolster up preconceived notions which have no foundation in fact. Thus valuable time is wasted, and the progress of scientific research is retarded as well. No scientist should start out in search of nothing. He must have an object in view, and that object must in a measure be defined. Science has no business to halt by the wayside and inquire whether or not the truths found in the book of Nature will horrify those who are nursing some creed or dogma. Truth is truth, and an apology for its existence received from any quarter is quite superfluous. If the truths of science have terrors for a man's religion there must be something wrong and untrue in connection with his religion. If his religion be based upon knowledge, love, justice, and mercy, he will encounter no terrors in the realm of science; if his religion means a desire to know the why and wherefore of existences about him and the determination to add his mite of power in helping to ameliorate human conditions, the truths of science will serve as his handmaiden.

The assumed cleverness and wisdom attributed, in the professor's article, to certain thinkers may apply in some instances, but no one realizes more fully than the student of Nature himself the *fact* that he knows but little and can never know a great deal. But he finds in this reflection no reason why he should quit his labors or even turn aside to ingeniously weave an apologetic yarn, lest his conclusions unmixed with sophistry might possibly horrify some prejudiced minds.

AN ARGUMENT FOR VERTICAL HANDWRITING.

By JOSEPH V. WITHERBEE.

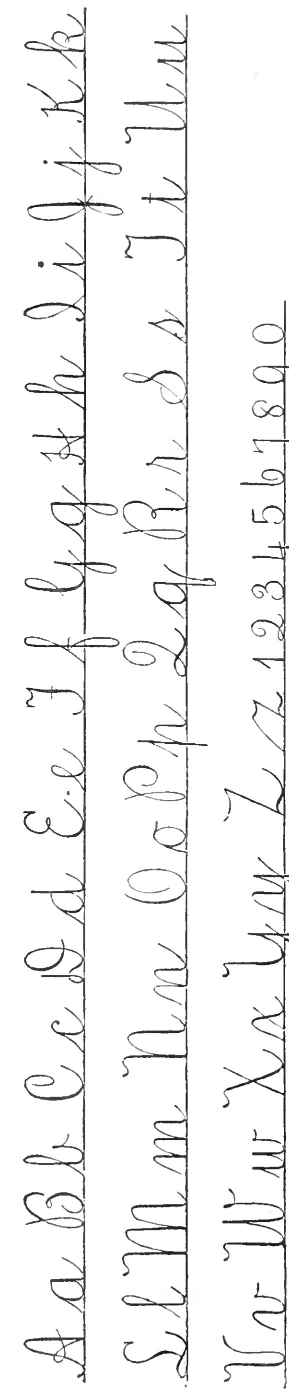
WHY is it that the business men of to-day find so much fault with the chirography of the boys who are seeking, or have obtained employment? They assert with great positiveness that the average boy of thirteen or fourteen years does not write legibly; that his labored copy-book hand, with its pale and sight-destroying hair-lines, is not at all adapted for business purposes. Their cry is for a style of penmanship that is practical, that a boy or girl can write rapidly, and that will not injure their eyes when forced to read it for any length of time.

It is the purpose of this article to show that there is such a style of penmanship, that it is easier to teach, that it is easier to read, that it is more rapid, and that, from a hygienic point of view, it is incomparably superior to the present slanting writing.

In England, I believe, Prof. John Jackson is the pioneer in the new style of writing; and now, so much favor has it found over there, by reason of its superior legibility, that the examiners require its use in all branches of the civil service. Sampson Low & Company, London, have published Prof. Jackson's copy-books, which have had a wide sale in England. Many English schools have adopted them and require their exclusive use. On the Continent the Austrian schools lead in approval and support of vertical chirography, though many of the more progressive German schools have taken up this system and are enthusiastic in its praise. As yet, I believe, no American publishers have issued a series of copy-books with the upright letters, though one house contemplates it in the near future.

From long and careful observation, I think every teacher of a beginner's class in school will bear witness to the fact that the first attempts of a new pupil with pen or pencil are nearly perpendicular, and that it is only by keeping constantly at him that the child manages to make his letters at the required slant of fifty-two degrees. Even then, after all his work with exaggerated copies

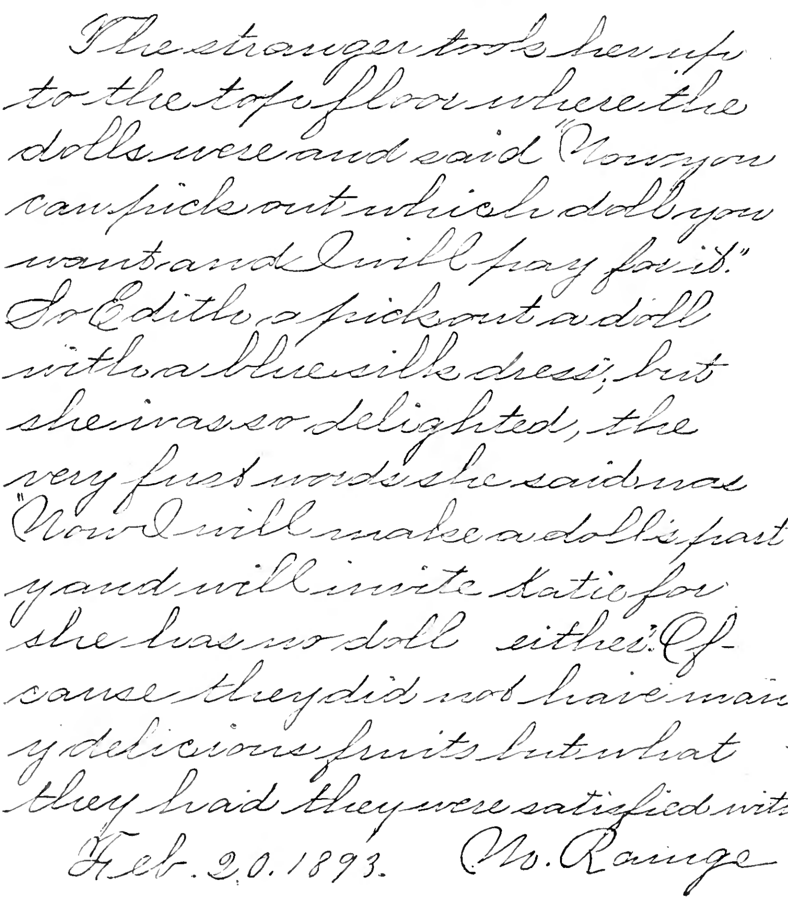
VERTICAL COPY-SLIP.



DIRECTIONS.—Sit squarely facing the desk with feet flat on floor. Raise seat so that both forearms, when placed half their length on the desk, are nearly level. Place paper squarely in front of breast-bone. Keep elbows close to body. Sit erect.

and other devices, if nothing more is said about the slope, he lapses back to his natural inclination to write straight. From this it would seem that the present mode of teaching penmanship is contrary to Nature, and therefore a great waste of energy. How much easier and pleasanter, too, it would be to adopt the vertical writing from the start, and thereby avoid that continual friction necessary to get the artificial slant!

I know not how to make clearer the second point—that straight writing is plainer to read than slanting—than by placing before


The stranger took her up
to the top floor where the
dolls were and said "Now you
can pick out which doll you
want and I will pay for it."
So Edith a pick out a doll
with a blue silk dress; but
she was so delighted, the
very first words she said was
"Now I will make a doll's part-
y and will invite Katie for
she has no doll either." Of-
cause they did not have man-
y delicious fruits but what
they had they were satisfied with
Feb. 20. 1893. M. Range

the reader actual specimens of the same pupil's work, written twelve weeks apart. The pupils selected are twelve and thirteen years old. (It may be well to state here that the class to which these pupils belong had but four weeks' regular instruction of thirty minutes a day, using the above copy-slips, printed on gummed paper, so that they could be readily pasted on the desk immediately in front of the pupil, or on cardboard, as suited the

teacher's fancy. The other eight weeks the class received sometimes two and sometimes three thirty-minute lessons per week.) Let it be understood that these are not isolated cases, but that every member of the class shows the same marked contrast. The slanting writing is part of a composition, while the straight writing was from dictation.

Now let the reader hold the page farther and farther from him until the vertical writing becomes indistinct, and then try his

A time there was, ere England's
griefs began,
When every root of ground main-
tained its man;
For him light labor spread her
wholesome store,
Just gave what life required, but
gave no more;
His best companions, innocence and
health;
And his best riches, ignorance of
wealth.

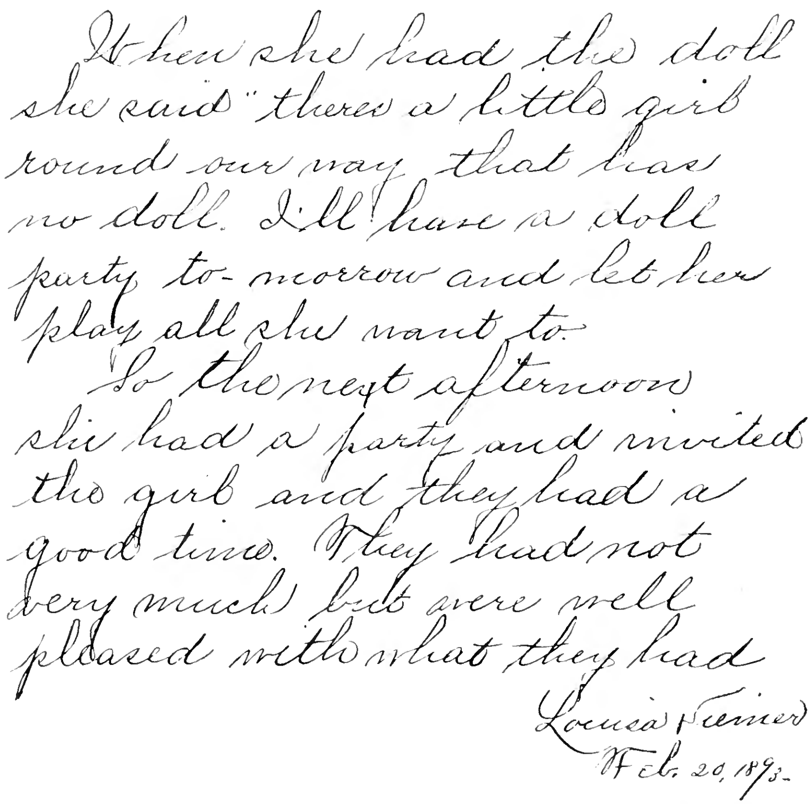
M. Mamie Range
May. 19. 1893.

eyes on the slanting writing at this distance. Unless his sight is different from that of a large number of persons whom the writer has tested, the universal verdict will be in favor of the legibility of the vertical writing. The test becomes much clearer when a short-sighted person, who wears glasses, takes them off and tries to read the two styles of writing. To such people, so plain is the proof that they wonder why straight writing has not been adopted in the schools long ago.

It is claimed that vertical writing can be more rapidly written than slanting for the reason that the perpendicular of every right-angled triangle is shorter than the hypotenuse, and therefore

there is less distance for the pen to travel in making vertical lines than in making slanting lines. The mathematical fact here enunciated will not be denied nor can the deduction be refuted, and yet I fear many will still deny that upright writing is more rapid than sloping writing.

To the parent as well as the educator the position of the pupil when writing should be of the greatest interest. That there is an alarming increase of spinal curvature and near-sight in children of the present day goes without saying. There must be some reason for it. If we accept the statement of the Vienna commission of


When she had the doll
she said "theres a little girl
round our way that has
no doll. I'll have a doll
party to-morrow and let her
play all she want to.
So the next afternoon
she had a party and invited
the girl and they had a
good time. They had not
very much but were well
pleased with what they had
Louisa Feiner
Feb. 20, 1893.

experts appointed to investigate the cause of this increase, we find it charged to the account of sloping writing, with its unavoidable faulty positions. Compare the pictures of two children as actually found in class, and let any one say which child stands the best chance of growing up with a straight spine and unimpaired eyesight if kept in these postures long at a time. Observe that the position of the girl on the right in the first cut is by no means an exaggerated one, but quite as favorable to the advocates of sloping writing as they could ask for, and yet the twisting of the

head and the curvature of the spine are noticeable here, the latter more especially in the second cut. Notice, too, that the other girl, who is in the correct position, might lean forward however much she pleases, and still her shoulders would be of the same height.

If the pupil who slants his letters sits sidewise to the desk (a very common position), not only is one shoulder usually higher than the other, but the head is commonly turned until a line connecting the pupils of the eyes is parallel to the line on which he

A time there was, ere Eng-
land's griefs began;
When every rude of
ground mantained its man;
For him light labor
spread her wholesome store,
Just gave what life re-
quired, but gave no more:
His best companions, in-
nocence and health;
And his best riches, ig-
norance of wealth.
Louisa Dremer,
May 19, 1893.

is writing. Nature impels him to twist his neck so that one eye shall be the same distance from the letters he is making as the other. Unless he does turn his head, the eyes are not equidistant from his work, which tends to shorten the sight of one eye and lengthen that of the other. This accounts in large measure for the need of two glasses of different power for the same person, so frequently met with at the present time.

It is hardly worth mentioning that vertical writing takes up less space than sloping writing, as this is self-evident and only needs stating to be admitted. Years ago, when paper was costly, this argument would have more weight than now.

Let me digress a little, to enter a protest against the use of double-lined paper after the first year of a pupil's school life, and to express my belief that it is altogether unnecessary in the primary school. A child does not need a walking machine after he has learned to walk; neither does he need a guide-line in penmanship to dwarf his eye-training and judgment of distance after he can distinguish the difference between a whole space and a half space. In my opinion, any child of ordinary ability in the primary school distinguishes half an apple from a whole one, or half an inch from a whole inch—not in name, to be sure, but in reality—long before he enters the school. It is an undisputed fact that the longer a pupil uses the double-ruled paper, the more he misses the guide-line when it is taken away. It has been proved that first-year pupils can get along without the second line from the very outset practically as well as with it, and they thereby

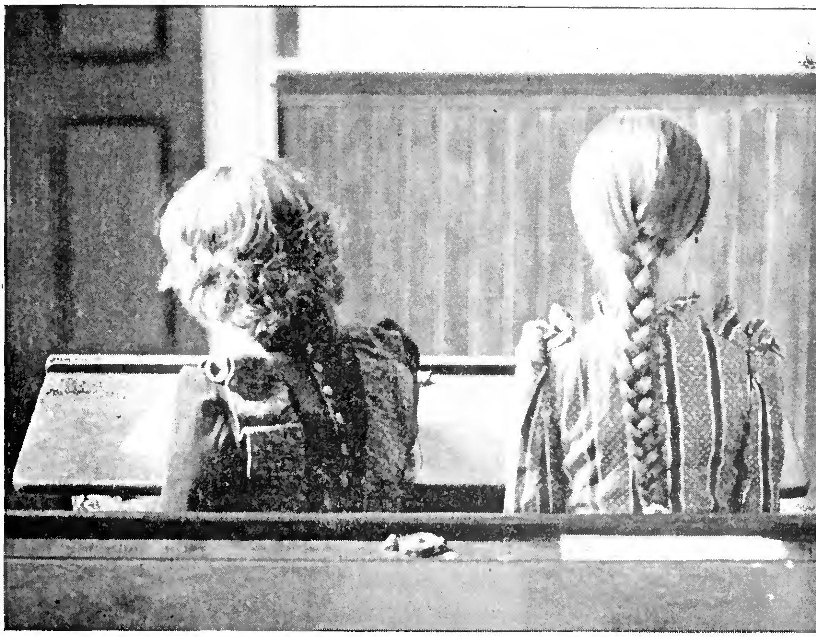
Hygienic position. Unhygienic position.

FRONT VIEW.

avoid learning to write twice, as it really amounts to a second beginning when the single-lined paper is taken up for the first time at the fourth year. In some cities this is the period in the child's school life when much more writing is required, necessitating more rapid work on the part of the pupil. Hence, instead of one difficulty at a time, a long-honored rule of pedagogics, the child loses his guide-line when he has become most accustomed to

it, and is forced to wield his pen more swiftly than before. Is it to be wondered at that children, struggling against these two difficulties at once, show poorer penmanship, as a rule, the first year after dropping double-lined paper than at the end of the first year of school life?

Some educators say that vertical writing is a "fad" that will run its race and die like all fads; but there is this important fact



Unhygienic position. Hygienic position.

BACK VIEW.

to be noticed, that they never have tried it themselves, and, because it is new, therefore it must be fleeting. Grant them that vertical writing is not more legible, more easily taught, and more rapidly written than sloping writing, all false as false can be, the simple fact that it puts the pupil in a perfect position in regard to the spine and the eyes is bound to win its way into popular favor. Vertical writing has come to stay.

THE porcupine, which was living fifty years ago in Andalusia and Estremadura, Spain, has wholly disappeared from these provinces. The ichneumon, Meloncillo, which was formerly common in many places, has become very rare. The Magot monkey is preserved at Gibraltar with much difficulty by frequent renewing of its blood. The Meloncillo ichneumon was a favorite animal with the Spaniards before the domestic cat was introduced, and is still, according to Señor Regnera, greatly esteemed by the inhabitants of the Sierra Morena.

VEGETABLE DIET.

By LADY WALB. PAGET.

I DO not write this paper with the intention of converting or even convincing anybody, for nobody is more impressed with the great truth that what is good for one person is not good for all. The infinite individuality of the human race is what distinguishes it from animals. A certain kind of food will be liked and digested by all animals belonging to the same species, while, as an eminent doctor remarked the other day, there is not one article of food in the whole world which is eaten with pleasure by every human being alike. All I wish to do is to put my experiences before those to whom they may be useful, and who may profit by them without making the disagreeable mistakes my ignorance led me into.

I have all my life thought that meat-eating was objectionable from the æsthetic point of view. Even as a child the fashion of handing around a huge *grosse pièce* on an enormous dish revolted my sense of beauty; and I was delighted when, on my first visit to England, a small and thin slice of beef was unobtrusively shown to me behind my left shoulder, to be accepted or rejected *ad libitum*. I quite agree with Lord Byron, who said he would not marry a pretty girl because she had asked for two helps of lobster salad, though if beefsteak had been substituted I should understand it better still. The *biftek à l'anglaise*, which seems to be the only idea a foreign waiter ever has when he is asked to suggest something to eat to English-speaking travelers, is simply a piece of hot raw meat, far more fit for the Zoölogical Gardens than for human food; for, despite of constant and sometimes indignant disclaimers, it is generally believed on the Continent that it forms the staple food of the British nation—that the strong limbs of the young men, the lovely complexions of the girls, and the bright eyes of the children are entirely due to this nourishment, and anxious mothers of families abroad are constantly impressing upon their offspring and everybody else about them the utility and necessity of this panacea, if they wish to be in good health and feel fit and strong. It is a curious fact that in places where this regimen of *viande saignante* is followed anæmia is very frequent.

I have been told, though I have not read it myself, that somebody has written a description of a town where the whole population was vegetarian. The change this would make in all the sights and smells is far greater than we at first imagine. The ghastly butchers' shops which meet one at every turn appear to me an incongruity, not to say more, in this civilized age; they

would disappear, as well as the fishmongers', which are hardly any better. Then there are the sausage shops, which, especially in southern countries, persecute one with their pungent odor. How often have I been driven away while admiring the façade of an old *palazzo* or the portico of an ancient church by the emanations of the terrible *pizzicheria* half-way down the street! Another dread sight which meets our eyes abroad, especially in Germany and Austria, where much veal is eaten, are the slaughtered calves paraded about the streets, a dozen or two of them hanging over the sides of the cart. There can be little doubt, too, that our kitchens and dining-rooms would be far more sweet and attractive if no animal food was ever brought into them. The eyes certainly would be gainers, and our olfactory senses too. In pictures and in poetry the tables are laid out with luscious fruit and sparkling wines, whenever charming and pleasant scenes are to be conjured up before our minds. When coarseness and discomfort are portrayed, "men brought in whole hogs and quarter-beeves, and all the hall was dim with steam of flesh." It is the difference between one of Giulio Romano's garden banquets, such as he painted in the vaulted chambers of the Palazzo del Te, and a peasant orgy by Ostade or Teniers.

It is not, however, this aspect of the Pythagorean *régime* which will make many converts, nor did it ever influence me for very long, as most doctiors lay, or rather laid, about twenty years ago, so much stress upon the eating of sufficient meat and the anæmic tendency of this generation, that one naturally felt it one's first duty to prefer health to beauty.

A more serious consideration, and one which grew upon me every year, was the sad and distasteful necessity of killing a living being in order to live one's self. The great mystery of pain in this world, which if it once gets a hold upon the mind is so terribly difficult to shake off, often dimmed my greatest pleasures. But this feeling too I tried, but less successfully, to subordinate to what I then considered right and reasonable.

The first serious shock I experienced in this theory was when, a few years ago, one of the most eminent German professors from a great university dined at our table, and would not touch anything because he was a vegetarian. I looked over the bill of fare, and realized with consternation that everything down to the sweet was either meat or fish or fowl, that vegetables and farinaceous food played the very smallest part in it, and even they were tainted with sauces not free from reproach.

I had the evening before listened to an historical discourse delivered by Prof. O—— to an audience of all that is most intelligent and distinguished in this city. I had been struck by his extraordinary vigor and clearness. The words dropped like pearls

from his lips, and though the voice was scarcely raised it appeared to search out the remotest corners of the hall. Every rounded-off sentence presented a vivid picture to the mind. The subject was the chancellor Prince Metternich, and we all felt when, after an hour and a half, Prof. O—— ended apparently quite as fresh and collected as when he began, that we not only knew the prince personally, but that we understood his politics and the workings of his mind far better than his contemporaries had done. The thing which, however, impressed me most, was the sense of power held back, and to the good as it were, which the professor gave me while speaking, and even after he had finished. When, therefore, the next day he told me that he never touched animal food, I was very curious to hear his experiences.

He told me that some years before he had been very ill, nigh unto death, and given up by all the doctors. Then came one who said he could cure him. All the strong soups and beef jellies and raw minced meat were eliminated and replaced by fruit and light farinaceous food, but fruit especially, and he soon got well and strong—so well and strong, indeed, that he determined to go on with his simple fare, especially as he felt an unwonted ease and extraordinary lucidity of the intellect when working. His wife, he told me, soon followed his example, and also his daughters and sons-in-law. At last his servants came and said they would like to be vegetarians too, as it seemed to agree so well with their masters. I felt that where so clever a man was so fully convinced of the expediency and efficiency of this diet that he carried his whole family and household with him, he must have gone into the question deeply, and have the very best reasons upon which to found his belief. I could not enter with him into further discussion, as he had to leave Vienna, but he sent me some books on the subject. These books were German, and they would be well worth translating, for their whole tone is like a bracing mountain air. In every one of them vegetable diet is the foundation whereon is built an edifice of hygiene, which if we could or would but strictly follow might bring us to a pinnacle of animal spirits and bodily vigor only to be compared to the centaur of Henri de Guérin. To those who have not read this charming fragment, let me recommend it as a tonic on a day of languor and prostration. The thorough enjoyment of life and strength in which the centaur revels while careering over wind-swept plains, down breezy mountain-sides, plunging into deep green forests with the scent of the earth and wood flowers in the air, is better than any dose of sal volatile or quinine. These little German books, for none of them are very long, have mainly for their object to bring us back to a healthier and simpler mode of life. They are full of cold water and open windows by day and by night. Sun-baths and

air-baths in the woods and on the hills, swimming and gymnastics, everything on the simplest and most economical lines, as they are mainly written for schools and the middle classes, where expensive adjuncts must be omitted. No medicines are tolerated by the strict vegetarian; everything is cured by diet, exercise, water, hot or cold, or in the shape of steam.

There are now all over Germany and Austria a great number of what are called "Nature doctors," who cure on these principles, though they need not necessarily be vegetarians. The poor prefer them, as they are often men well off, who have a vocation for this calling; the medicaments cost very little or nothing. Father Sebastian Kneipp, at Wörichshofen in Swabia, belongs to this class, and the thousands he cures every year have made his name famous in all the German-speaking lands. He too deprecates the use of much meat. Everywhere baths and sanatoriums are springing up where cures with these simple means alone are effected, and medicines utterly discarded. The Hygeia, a publication founded by the well-known Dr. Paul Niemeyer, and edited at Munich by his disciple and successor, Dr. Gerster, is one of the many organs of the new and independent school; many doctors and a few laymen write in it. It is interesting and amusing, full of unexpected information, and much read by the most intelligent section of the public. The German vegetarian books are full of a number of excellent recipes for dishes of all kinds, suited to every time of the year and to different countries, which is most important, for the new-fledged vegetarian always thinks he is going to die of hunger. In the preparation of vegetables the German Pythagoreans bear off the palm, and I am bound to say that even their puddings and sweets are better than those known to the meat-eater. From what I have heard of English vegetarianism, I fancy that the movement, which in many respects might prove so useful, is much impeded by the inadequate way in which the vegetables are cooked, and until this defect is thoroughly remedied, and a greater variety is introduced into the vegetarian bill of fare, there is no prospect of an extension, which might prove so great a boon to the poorer classes.

In spite of the persuasive language of my books, and the promise of health and happiness, I could not, somehow, make up my mind to take a step which I imagined would in a certain way cut me off from my fellow-creatures; and it was not till rather more than a year ago, when I was obliged to read up certain papers about the transport of cattle and slaughter-houses, that the irresistible conviction came upon me that I must choose between giving up the eating of animal food or my peace of mind.

Years ago, when I lived in Italy, this same subject had given me much pain. At Rome it was the habit for every butcher to

have his own boys in the slaughter-houses to kill the cattle. These boys were often unskillful or not strong enough. When the beautiful milk-white oxen, with their large, pathetic black eyes, were brought to be slaughtered, these butcher boys had often to give thirty blows before the poor beast fell. Every animal that was brought into the town paid by weight at the *octroi*, but they were generally kept waiting for days in sheds outside the town. In these sheds there were drinking-fountains always running, but the plug at the bottom was taken out, so as to prevent the animals from drinking, and thus their weight was lightened. The railway companies never dreamed of watering the cattle during the many days that they were packed together in the trucks, sweltering and faint under the fierce Italian sun. The Roman Society for Protection of Animals sent a dozen pails to Foligno, a central railway station, offering to pay a certain sum annually for the watering of the cattle. The pails were returned after two years, never having been used once. Nor are things much better in this country. The cattle which come up from Transylvania and other distant parts of the empire are neither fed nor watered on the journey, which sometimes takes a week. Then when unshipped they are tied together in threes and fours, hit and frightened, and thus driven to the slaughter-houses. They sometimes fall down in the road from terror and exhaustion.

Galician pigs often lie in thousands for a week together in the snow and slush outside the slaughter-houses, waiting to be killed. Thus far my own experience and things I have seen. In England, if I am to believe newspaper paragraphs and statistics, things are as bad if not worse. For a short *résumé* of the horrors attending the transport of cattle by land and by sea, let anybody whom it interests turn to pages 65–69 of Dr. A. Kingsford's Perfect Way in Diet, headed The Sufferings of Cattle, and they will learn well-authenticated facts which will fill them with pain and disgust. The following figures are sufficiently significant. They are taken from the report of the Veterinary Department of the Privy Council for the year 1879.

In 1879, 157 cargoes of Canadian cattle were shipped for Bristol, Glasgow, Liverpool, and London, in which total there were 25,185 oxen, 73,913 sheep, and 3,663 pigs; but of this number 154 oxen, 1,623 sheep, and 249 pigs were thrown into the sea during the passage, 21 oxen, 226 sheep, and 3 pigs were landed dead, and 4 oxen and 61 sheep were so wounded and suffering on arriving that they had to be slaughtered on the spot. In the same year there were shipped from the United States for the ports of Bristol, Cardiff, Glasgow, Grimsby, Hartlepool, Hull, Leith, Liverpool, London, Newcastle-on-Tyne, South Shields, and Southampton 535 cargoes of animals, of which 76,117 were oxen, 119,350

sheep, 15,180 pigs; but of this number 3,140 oxen, 5,915 sheep, and 2,943 pigs were cast into the sea during the transit; 221 oxen, 386 sheep, and 392 pigs arrived dead at the place of landing; and 93 oxen, 167 sheep, and 130 pigs were so mutilated that they had to be sacrificed on the spot. In *résumé*, 14,024 animals were thrown into the sea, 1,240 were landed dead, and 455 were slaughtered on the quay to save them dying of their wounds and sufferings. One asks one's self what state the remaining animals were in, which were sold for human food?

It is not an unnatural or far-fetched idea to connect this state of things with the excessive and inexplicable extension of cancer within the last decade. The more and the further cattle are transported under these conditions, the more tainted (though perhaps not perceptibly so) meat must be eaten, the more poison is infused into the blood. It is not possible that the flesh of an animal which has been knocked about, frightened, starved, exposed to the heat of the sun or icy cold for days and weeks, should be as healthy as that of those taken from our own fields and slaughtered at once, as was the case in the days of our ancestors.

These considerations, however, were not the only ones that moved me. I do not think that anybody has the right to indulge in tastes which oblige others to follow a brutalizing occupation, which morally degrades the man who earns his bread by it. To call a man a butcher means that he is fond of bloodshed. Butchers often become murderers. I remember two cases in the papers last summer where butchers had been hired to murder individuals whom they did not even know. After this comes the irrepressible thought, Is it right to take life in order to feed one's self, when there is plenty of other available food which will do just as well?

Having answered these questions to my own satisfaction, I plunged at once into full-blown vegetarianism. I got very little to eat, and that not very good, for neither I nor my cook was *à la hauteur* of the situation. I had, however, one, and that a very great compensation—I felt superior to my fellow-beings, treading on air, my head delightfully clear, and altogether lifted up above material things. The poet laureate's lines to Fitzgerald will give in a few words the story of my first and unsuccessful attempt:

> ". . . live on milk and meat and grass;
> And once for ten long weeks I tried
> Your table of Pythagoras,
> And seemed at first a thing enskied
> (As Shakespeare has it), airy-light,
> To float above the ways of men,
> Then fell from that half-spiritual height
> Chilled, till I tasted flesh again."

I, too, felt chilled and sleepy by day and night, so tired that I could hardly walk. The doctor said: "You have no pulse at all, and must give in; it does not suit you." The winter was icy cold and depressing, and for the moment I followed Tennyson's example. *Mais je ne reculais que pour mieux sauter*, and with the first breath of spring, when all those delightful fruits and leaves and roots which Raphael did not disdain to paint as ornaments in his loggias reappear on our tables, I made my second methodical and successful attempt, eliminating week by week one kind of animal food only, and replacing it by some equally nutritious vegetable preparation.

The very strict ascetic sect of vegetarians who only live upon seeds and uncooked food look down upon their weaker brethren who eat eggs and milk and butter, in fact, everything which does not necessitate the taking of life, which appears to me to be the only reasonable standpoint. I will not, therefore, enter into discussions whether our teeth are those of a carnivorous or frugivorous animal, though the latter appears to me the most likely theory, as fruits are the only edibles we can eat and digest without cooking; everything else requires the aid of fire to make it palatable and wholesome. It is certain that the giving up of animal food cures many illnesses which no medicines can reach. Everybody knows the bad effects of butcher's meat in gout and rheumatism. In affections of the heart it is often the only remedy, and the wonderful results are not difficult to explain in a case where rest often means cure, if one reflects that while the meat-eater's heart has seventy-two beats in the minute the vegetarian's only has fifty-eight beats, therefore twenty thousand beats less in the course of the twenty-four hours. Insomnia and nervousness are affected in the same way; there is less wear and more repose in the constitution. I could enumerate many other illnesses in which vegetable diet does marvels, but will only mention those of the skin. Most vegetarians have unusually clear and often beautiful complexions. I need only remind those who know them of the old Carthusian and Trappist monks, who all have smooth white and pink *Fra Beato Angelico* kind of faces, which are not found among the orders that do not habitually live on Lenten fare. The splendid teeth of the Italian peasantry, who never touch meat, speak for themselves, and it is the same in other countries where the people live under similar conditions. It is foolish to associate vegetable diet with temperance, as so many do: they are quite astonished to see a vegetable-eater drinking wine or beer. One thing, however, is true, viz., that it is far easier to cure a drunkard if you deprive him of meat, because, as Dr. Jackson, head doctor of the Asylum for Dipsomaniacs, Dansville, United States, says: "It is clear that meat contains some not nutri-

tious particles, which excite the nervous system so much that it at last becomes exhausted and unstrung. In this state of exhaustion unhealthy reaction follows, which brings on a paroxysm and violent desire for spirits and the excitement which they create." G. Bünge, Professor of Physiological Chemistry at the University of Bâle, writes, in his book on vegetarianism, page 33: "The appetite of the drunkard is directed almost exclusively to animal food, and vegetarians are quite right when they teach that spirit-drinking and excessive use of animal food are in connection with each other."

Vegetarianism is often called a fad, but it is a healthy and an innocent one, and the natural reaction against the present state of things. It imparts lightness and elasticity to the body, brightness and clearness to the mind. The vegetarians I know are all unusually strong, active, and young-looking people for their age: one of them walked without stopping for thirty-four and another time twenty-seven hours, without a rest, while on an excursion in Norway, feats not easily equaled by the most inveterate beef-eater. Traveling, mountain-climbing, all seem easier and less fatiguing on this light and soothing diet; and why should it not give strength to the limbs and sinews if one reflects that all the strongest animals who do the heaviest work in the world, like horses, oxen, and elephants, are entirely herbivorous?

There is, of course, a great deal more to say on so wide a subject, but I have in these pages confined myself almost entirely to my own experiences. Being but a beginner myself, there is much for me to learn, and I have not even touched on the possibilities and probabilities this theme opens out into the domain of psychology. But only a few days ago one whose experience and knowledge on this subject are greater than those of most men told me he owed almost everything he had attained in his domain to his strict adherence to a vegetable diet. It certainly gives, to those who live on these lines, a kind of detachment from material things, a sense of calm and content. It is in the hope of helping some who may feel nervous and worried in mind, or ill in body, that I write these lines, to point out a simple remedy everybody can apply. It not only costs nothing, but even puts money in our pockets—only, like everything else, it must be governed by good sense and reason in order to be successful.

It is not my intention to be understood to say that I look upon vegetable diet, even with its necessary accompaniments of fresh air, frequent ablutions, gymnastics, and exercise, as a panacea for everything, and that medicines become useless. We are mortal, and there is no perfection in this imperfect world. Nobody has a greater belief than I have in remedies judiciously given during illness, but it is the many who are out of health and below par,

without hardly knowing what is the matter with them, who would be all the better for trying whether their discomforts spring from too high and rich a diet or from the inability to procure any but inferior meat or fish. In the first case they would soon feel their tired digestions rested and their irritated nerves calming down, while in the latter they would find out that it is easy to get a healthier and an equally satisfying meal for half the cost of what they were in the habit of spending before.

Though these motives are not perhaps the highest which ought to lead us to a result, they are those which exercise a most general influence. The small number who change their mode of life from principle only know how far above bodily health the blessings are which grow out of the sacrifice. Before the eyes of everybody the lines of the Latin poet must conjure up a delightful and attractive picture:

> "Forbear, O mortals, to taint your bodies with forbidden food;
> Corn have we; the boughs bend under a load of fruit;
> Our vines abound in swelling grapes; our fields with wholesome herbs,
> Whereof those of a cruder kind may be softened and mellowed by fire.
> Nor is milk denied us, nor honey smelling of the fragrant thyme;
> Earth is lavish of her riches, and teems with kindly stores,
> Providing without slaughter or bloodshed for all manner of delights."

ORIGIN OF THE MISSISSIPPI VALLEY RAINFALL.

By J. HARRIS PATTON, Ph. D.

It has been assumed that the evaporation off the Gulf of Mexico furnishes the most part of the rainfall of the great valley. Says an authority, when speaking of that of the whole country, "By far the greater portion comes from the gulf and spreads over the central and eastern part of the Mississippi Valley, and even much of the Atlantic slope." Let us examine the data on which this statement is based. The area of the Mississippi Valley is estimated at 1,244,000 square miles, and the annual average rainfall on its surface is forty-two inches—that is, if the rain water did not penetrate the earth, run off, or evaporate, at the end of the year the depth would be three feet and a half.

The area of the Gulf of Mexico is estimated to be one fourth that of the valley. It is easily shown by mathematical calculation that it would require an annual evaporation off this area of fourteen feet to furnish the required rainfall, even if all the water thus raised into the atmosphere were utilized. Again, the area of the gulf is swept by the extreme right flank of the trade winds. These winds must carry toward the west a large portion of the

surface vapor rising off the gulf; this is evident because of the unusual distance to which the sea-breeze penetrates into Texas and the adjoining region of Mexico. In addition, the water of the gulf is not as warm as that of the Atlantic equatorial current—to be noticed presently—by an average of *ten* or *twelve* degrees Fahr., and in consequence, in proportion, its evaporation is just so much the smaller. The equatorial current penetrates the gulf about five hundred miles, but does not diffuse itself and thus impart its heat to the adjoining waters, but in a compact body the current turns toward the east and finds its way out through the Florida Strait, and thus becomes the Gulf Stream.

It is estimated that if the "gulf was landlocked and evaporation checked," the volume of water poured into it by the Mississippi alone would "raise the level of this great area one and a quarter feet each year." (Appletons' Physical Geography, p. 130.) The height of the surface of the gulf, however, remains uniformly the same year in and year out. It follows from this that the outflow of water and its evaporation combined amount each year to only one foot and a quarter. This leaves twelve feet and three quarters to be obtained elsewhere, in order to furnish the rainfall for the great valley. The question is, Where can this be obtained?

The Atlantic equatorial current may furnish an answer. This vast stream is about four thousand miles long and about three thousand wide. Taking its rise in the Gulf of Guinea, it flows westwardly, but, dividing on Cape St. Roque, the much greater portion moves along the north shore of South America, and just before entering the Caribbean Sea it unites with the northern counter current. (See Appletons' Physical Geography, pp. 50, 51.) These currents are both under a broiling tropical sun, and their water is heated from 80° to 82°; "the evaporation is rapid in the equatorial regions, and most of all in the warm belts constantly swept by the trade winds." Thus, when the warm, saturated air next the surface rises, it is rapidly carried away by the wind, and cooler air flowing from the north takes its place, to be in turn heated and floated upward. Says Captain Maury, U. S. N. (Geography of the Sea, p. 102), "Off this ocean belt there is, in the form of vapor, annually floated up into the higher air fifteen feet of water." Says Prof. Arnold Guyot, in Earth and Man, p. 85, when speaking of the same, "The sun causes these invisible vapors to rise, which, being lighter than the air itself, increasingly tend to soar into the upper atmosphere, filling it and constituting within it another aqueous atmosphere." This vapor is carried by the trade winds steadily westward at the rate of about thirty or thirty-five miles a day, and meets its first obstruction in the plateau of Mexico, which is five thousand feet above sea-level. On the west coast of Mexico stand the Sierra Madre Mountains, whose altitude

is five thousand feet above the plateau (Appletons' Physical Geography, p. 23). The latter furnish the second impediment to the onward progress of these winds, since they run southeast-northwest; but the trades blow directly west, and thus impinge upon them at an angle which deflects the winds themselves toward the north.

The Sierra Madre are more than one thousand miles long, and are an insuperable barrier to the progress of these vapor-loaded winds. This is evident, as there is no indication of their presence on the west side, neither on the land nor on the water, as the Pacific trade winds appear to originate about one hundred and fifty miles west of the coast of Mexico. An analogous case is cited by Prof. Orton, in his Andes and the Amazon, p. 118, who says, when speaking of the Andes, "So effective is that barrier that the trade winds are not felt again on the Pacific till you are one hundred and fifty miles from the coast."

These winds appear to be shoved up, strata upon strata, on the Mexican plateau, and when they finally reach the Sierra Madre Mountains, over which they can not pass, they are rolled back upon themselves. They must have an outlet. The rushing wind from the east prevents their moving in that direction, and the force of the main current forbids their flowing toward the equator, and thus their outlet can only be toward the north. They are now so high that they must be beyond the influence of the rotary motion of the earth, and are governed by the force of gravitation alone. In accordance with the latter law they flow, as on an inclined plane, over the colder and more dense air toward the north, and thus restore the equilibrium of the atmosphere that has been disturbed. This disturbance is caused by a continual flow of the cold and heavy surface air from the extreme north toward the equator, because along the tropical belt a partial vacuum is created by the air becoming heated and lighter and in consequence floating upward, and the cold air rushes in to supply that vacuum.

These comparatively warm strata, though high in the atmosphere, have a tendency to reach the earth, but, being lighter than the surface air, they float above it until their respective densities are about the same. The point of contact with the earth of the *lower* strata of these "return trades" is near 30° north latitude in the summer, but still further north in the winter. This point of contact is near and along the north shore of the gulf, and the blending of the moisture of the "return trades" with that off the gulf may account for the unusually large rainfall of sixty inches near that line; meanwhile the main and higher strata blow on and reach the earth further north.

"The polar winds, seeking the equator, strike obliquely against

the Rocky Mountains, and in running along their eastern slopes are deflected to the southeast, and become the northwest winds of the valley of the Mississippi. . . . These cool winds meet the surplusage of the moist return trade winds, and by their coolness condense still more the latter's vapor, which descends in rainstorms that are sometimes quite violent, but furnish water for the head streams of the Missouri and its branches" (Prof. Guyot, Earth and Man, p. 100).

It has been suggested that this warm air, thus saturated with vapor, loses the latter when it floats aloft, because of the cold in the higher regions of the atmosphere, and consequently such air, floating north, could not deposit moisture when it reached the earth. That theory is not consistent with the fact that vapor often becomes visible in the form of clouds, which frequently float higher than the altitude of the Sierra Madre. In this special case it is worthy of notice that the plateau of Mexico is five thousand feet above sea-level, and it is also under a tropical sun, and therefore the incumbent air is so much the more heated. In such circumstances the vapor-loaded winds would not be likely to lose so much of their warmth and moisture as under conditions wherein there was no similar elevation. The great valley being free from mountain barriers at both ends, the winds flowing either way are unobstructed. In consequence, the comparatively warmer and vapor-loaded winds off the equatorial current meeting those coming from the north that are nearer the surface and also cooler and drier, the moisture of the former is condensed into mists and clouds, and finally descends to the earth in copious rains.

One of the most perfectly adapted pieces of machinery for handling heavy weights is the modern "rapid-transit elevated railway traveling crane," which has been found highly useful in manufactories of locomotives and other ponderous machinery. Before it was introduced, heavy weights were moved from one part of the shop to another by means of jib cranes, the arms of which swung in arcs of a circle. A series of them occupied the middle of the floor. The weight to be moved was swung upon one of them and borne round to the next, when it was changed; and so on, till it reached its destination. These machines cumbered the floor, and were otherwise inconvenient. The traveling crane requires no floor room, but is wholly poised above. It consists of four essential parts: (1) the elevated tracks, which are supported by iron columns or built into the walls and run parallel with the walls from one end of the building to the other; (2) the traveling bridge, which is constructed of two parallel plate girders extending from rail to rail, spanning in mid-air the breadth of the building and mounted on wheels; and (3) heavy steel tracks laid between the girders, bearing (4) a trolley car, which runs back and forth, carrying the hoisting mechanism. By the longitudinal motion of the bridge and the cross-motion of the trolley, every square foot of available space in the building can be covered, and the position of a steam boiler or of a locomotive engine changed at will.

MATHEMATICAL CURIOSITIES OF THE SIXTEENTH CENTURY.

By M. V. BRANDICOURT.

IN the great intellectual revival of the sixteenth century, mathematics as well as letters and the arts were recuperated first from the pure sources of antiquity. Casting away poor Latin translations, second-hand versions through the Arabic, on which the Middle Ages had fed, geometricians emulated one another in zeal for learning the Greek language, in order that they might read in the original text the works of Euclid, Archimedes, Ptolemy, and Diophantus. Most of the works published at this epoch were only translations from Grecian authors. "The great thought of that time," says Montucla, "was simply to refine the minds of students and cause them to taste of a learning almost unknown till then. This could not be done all at once, and the human mind, like a weak stomach which too solid food would tire out, had to be brought by degrees to considerations of a higher order."

One of the earliest translations of Euclid is found in the *Margarita philosophica* of G. Reisch, prior of La Chartreuse at Friborg—a Latin book printed in Gothic characters at Heidelberg in 1496. It is a sort of encyclopædia of the science of the beginning of the sixteenth century, and certifies to the very extensive knowledge of the author. Each of the scientific treatises contained within it is adorned with very curious engravings of a naïve character.

Memmius, a noble of Venice, made a translation of the works of Apollonius in 1537, which was published after his death by one of his sons.

The mathematical sciences were then cultivated with most success in Italy; and when Francis I, of France, sent across the Alps for architects, painters, and sculptors to construct and adorn the magnificent châteaux of Chambord and Chenonceaux, he was thus also able to ask for his colleges algebraists who were certainly the first mathematicians in Europe. Algebra was not then what it has since become, a science employing only letters, signs, and symbols, having a well-defined significance and serving as the characters of a very clear and very precise language, which the initiated could understand as well as they could their mother tongue. The unknown quantity was then called "the thing" (*res, coser;* from which algebra was for some time named the art of the thing), and it was often represented by R. The square of the unknown quantity was called census (2). The signs + and = were not known, but the initials of the words for which they stand

were used. The sign — was not required, for the fruitful theory of negative quantities was not as yet known. In equations the coefficients of the unknown quantities were always figures, which became combined with the other factors during the operations, and of which no trace appeared in the final result. "We may conceive," says M. Chasles, in his History of Geometrical Methods, "that this cramped condition of imperfection did not constitute an algebraic science like that of our days, the power of which resides in those combinations of the signs themselves which assist the reasonings of intuition and lead by a mysterious way to the results sought."

Tartaglia Nicolo was an illustrious figure among the mathematicians of Italy. Born at Brescia in 1500, he was terribly mutilated at an early age, when his native city was captured by Gaston de Foix. His skull was broken in three places and his brain exposed, his jaws were split by a wound across his face, and he could not speak or eat. He nevertheless recovered, but always stammered, whence his name (*tartagliare*, to stammer). He was his own schoolmaster, and, after he had learned to read and write, devoted himself to the study of the ancient geometricians. At thirty-five years of age he taught mathematics in Venice. There he accepted a challenge which Fiori sent him, to solve twenty problems, all of which depended upon a particular case of cubic equations. Tartaglia solved them in less than two hours, and to commemorate his triumph composed mnemotechnic verses containing the solution. He was also the author of the ingenious formula for finding directly the area of a triangle of which all three of the sides are known.

Cardan Jerome, who was born in Paris, of Italian parents, September 24, 1501, was one of the most extraordinary men of his time. At twenty-two years of age, when he had just terminated his studies at the University of Pavia, he taught Euclid publicly. He also taught medicine, traveled in Scotland, Germany, and the Low Countries, and returning established himself in Rome as a pensioner of Pope Gregory XIII, and died there in 1576. Scaliger and De Thou assert that he had calculated the day of his death by astrology, and then starved himself to secure the fulfillment of his predictions.*

Such was the final eccentricity of this mathematician, who believed firmly in astrology and had visions, and he professed that

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* In one of his excursions to England he cast the horoscope of Edward VI, for whom he predicted a long life. Unfortunately, the king died in the next year. Having become used to such accidents, he was not disconcerted, but revised his calculations, rectified some of the figures, and found that the king had died in full accordance with the rules of astrology.

he had been informed in a dream of all that was to happen to him. His costume, his bearing, corresponded with his strange character. He appeared sometimes in rags, sometimes splendidly dressed; ran through the streets at night, and the next day was drawn in a three-wheeled carriage. Yet he published a treatise on mathematics, *Ars magna*, which was remarkable for the age. Pertinently to the publication of this work he had controversies with Tartaglia, of which something should be said, for the curious picture they offer of the manners of the learned world in the sixteenth century.

Tartaglia, as we have said, discovered the solution of cubic equations. Cardan employed toward him all the persuasions in his power to obtain a communication to himself of the famous discovery. "I swear to you on the holy gospels," he promised, "that if you teach me your discoveries I will never publish them, and will, besides, record them for myself in cipher, so that no one shall be able to understand them after my death." Tartaglia, trusting in Cardan's good faith, communicated to him his rules summarized in twenty-seven mnemotechnic verses, in three strophes of nine verses each. Cardan, assisted by his pupil Ferrari, succeeded in extending the rules, solved equations of the fourth degree, and published the whole in the *Ars magna*. Tartaglia, irritated at the algebraist astrologer's violation of his word, fell into a violent rage. He sent to his enemy, according to the fashion of the time, several challenges, and in one of them went so far as to threaten Cardan and his pupil that he would wash their heads together and at the same time, "a thing which no barber in Italy could do." Cardan finally agreed to attend a disputation, which was to be held in a church in Milan on the 10th of August, 1548. He did not appear, but sent his pupil Ferrari. Ferrari bore his part in the contest alone, and the affair would have resulted in favor of Tartaglia if the hostile attitude of Cardan's friends had not caused him to leave Milan by a by-road. "These mathematical jousts," says M. Victorien Sardou, "these challenges proclaimed by heralds and trumpets, with great parade of pompous words and swelling eulogies, were more becoming to charlatans than to really learned men; but charlatanism was then in fashion; a discovery was the finder's secret, and a method of calculating was speculated upon as if it was a new medicinal powder." We do not wholly agree with M. Sardou. We see an example of intellectual activity and find a proof of the importance that was attached to algebraic discoveries in these scientific tournaments in which all classes of society are interested—as formerly, in ancient Greece, they applauded the challenges of poets and the contests of athletes.

Leaving the Italian mathematicians and crossing the Alps, we

find in Paris Pierre de la Ramée (better known by his Latinized name *Ramus*) occupying at the *Collége Saint-Gervais* a chair of Mathematics which he had founded and which was subsequently made illustrious by Roberval. Ramus was born in 1515, at the little village of Cutry, and, a simple domestic at the *Collége de Navarre,* he found time to study all alone. He had the audacity at one-and-twenty years of age to sustain in the open Sorbonne, which swore by Aristotle alone, that all that the Stagyrite philosopher had said was false. Stranger still, "he seems to have convinced his judges, who conferred the degree of Master of Arts upon the bold innovator. Teaching philosophy, he continued to decry Aristotle. The Sorbonne was moved by his course to bring him before a tribunal, which declared him rash, arrogant, and impudent for having presumed to condemn the course and art of logic received by all nations." He was prohibited from writing and teaching contrary to Aristotle, "under penalty of corporeal punishment." He translated Euclid; and his *Scholæ mathematicæ,* in thirty-one books, was long used as a guide in the teaching of mathematics.

A mathematician of far superior merit to these was Viète, who expounded for the first time some of the most profound and most abstract theories that the human mind has ever invented. Born in 1540, in Poitou, he was appointed in 1580 *maître des requêtes* in Paris. His time was thenceforth divided between the duties of his office and the study of mathematics. He had an extraordinary power of labor. De Thou, his historian, relates that he sometimes spent three days in his study, taking no more food and rest than were absolutely necessary, and not leaving his chair or desk for them. He was commissioned by Henri IV to decipher some dispatches which the court of Madrid had sent to the Governor of the Low Countries. He acquitted himself very well of this difficult task—so well, indeed, that the Spaniards accused him of sorcery. He also solved in a few moments and in the presence of Henri IV a problem that had been proposed by Adrien Romain to all the mathematicians in the world. It was a problem extemporized as a diversion—an equation in the forty-fifth degree. The great analyst demonstrated that the equation depended upon the division of an arc into forty-five parts. He was the one who first in equations represented all the quantities by letters, with which all operations were performed which it had been usual to perform with numbers.

Viète published trigonometrical tables, in which he enunciated for the first time the law according to which the series of multiple or submultiple arcs increase. An enumeration of all his labors would require more space than we can spare. By his learned labors of analysis this man, the creator of mod-

ern algebra, prepared the way in which were to follow with giant steps, making themselves illustrious, Descartes, Fermat, Pascal, and finally Newton.—*Translated for The Popular Science Monthly from La Nature.*

BIRDS' JUDGMENTS OF MEN.

By M. CUNISSET-CARNOT.

WE put animals under all sorts of contributions, taking even their lives for our necessities, pleasure, and caprice, without once considering what their views may be of our proceedings or of us, or whether they have any views. We need not doubt that they have views, and some very definite ones. Mute witnesses of our lives, they examine, observe, and judge us; and some judge with a marvelous accuracy.

Birds, in particular, are all the time fluttering around us; they witness all our motions, interpret all our gestures, and very quickly form a perfectly just opinion of our character. The selection exercised by swallows has been remarked—they are said never to build their nests, except in quiet houses—and the prudence of the crow, which readily marks the difference between a harmless pedestrian and a hunter, and always keeps itself out of reach of the sportsman's gun, is well recognized. The accuracy of the observation of birds goes beyond this ordinary sagacity, and I am convinced that those birds which reside near man utilize for their advantage, security, or pleasure a multitude of very complete, fine, and judicious remarks which they make concerning their dangerous neighbor. I will tell here of two recent examples as a contribution to the study of the pyschology of birds.

The house I live in is situated in a faubourg of Dijon, in the midst of a garden surrounded by other gardens. The quarter is a chosen haunt of birds—nightingales, warblers, tomtits, finches, redthroats, wrens, etc., are abundant, besides the innumerable and undisciplinable army of sparrows. All the people of the house profess for the inhabitants of the garden feelings of the highest sympathy, which are manifested in numerous good ways by bathing-troughs judiciously placed in the shadows of thickets, various seeds put in good places where they will be found, by leaving the nests in absolute solitude, etc. There result such a cordiality and security of relation between our birds and us that the former sometimes manifest a familiarity in our quarters exceeding the limits of good taste.

Some time ago, the weather being pleasant, although it was as yet but little after six o'clock in the morning, I was working with

one of the windows of my room open. All at once I heard a sound of wings, and perceived a redthroat, its bill still bordered with the yellow characteristic of infancy, fluttering frightened across the room. It had probably, in its first attempt at flight, met a cat or a squirrel, and had taken refuge with me under the stress of a panic-stricken terror. It was so frightened that, in trying to get out, it did not see the open window, and beat obstinately against the glass of those which were shut. I thought it best not to interfere, lest I might frighten it still more; hoping, besides, that it would be more perspicacious when it had recovered its self-possession. It soon desisted from its attempts and perched itself on a corner of my bookcase. I watched it with the corners of my eyes without moving; I observed that its respiration gradually became more regular, and its expression resumed its calm. It completely recovered itself in a few moments, but, instead of trying to escape, it stayed where it was, uttering frequent light cries. In response to these calls, another redthroat came in, adult and experienced, evidently the father of our frightened one. He flew rapidly round in my room, like one examining the resources and means of the country; then, having beaten his wings for a few seconds before his offspring to encourage him to follow him, I fancied, he went out alone with a jerk of his wings, without missing the window. Here, I thought, is a father who takes things philosophically; sure that his chick will be in no danger, he plants it there and goes back to his business. But I judged too hastily. In less than a minute the father came back, bringing a caterpillar in his bill; he gave it to the little one, then went out, returned, and made twenty journeys for provisions, bringing in all sorts of insects, to the great satisfaction of the young one, which became quite contented and made itself well at home, erecting its feathers, smoothing them, working itself into a ball, and peeping. But its skill did not correspond with its appetite: it dropped the insects on my books, not to my pleasure; then there came a spider of respectable size, when, having a horror of spiders as unreasonable as unconquerable, and disliking the litter left by the little bird on my books, I thought it was time to give these creatures to understand that their familiarity was a little in excess of the limits. I opened all the windows, and, shaking my handkerchief, sent them to continue their feast in the woods.

Among our birds are a pair of redstarts which faithfully return to us every April. We are old acquaintances, and a degree of confidence is established between us above anything that can be imagined. These birds habitually make their nests, within reach of the hand, in a large ivy that grows on the wall near the garden gate. Whether this situation had ceased to please them, or some accident had happened to a first nest that we did not see,

they this year set up their household in a new spot, selecting the letter-box. One of the boards of the frame of the box having become detached, an opening was made in it large enough to allow them to pass back and forth. This box is fixed to a little foot-gate connected with the large wagon-gate, which is opened and shut more than a hundred times a day; about twenty inches above it is a bell that sounds loudly enough to be heard within the house, two hundred and fifty feet distant, which is rung every time the little gate is opened. I should say that, as soon as I saw my birds take the box for their house, I asked the postman to put nothing more in it; but when I perceived that the nest was in building, it was nearly done, and the letter-box had been used as such for nearly two days without the birds being troubled by it; and I should add that during those two days the box was emptied by a groom too small to see to the bottom of it, and the nest being in a corner, he had not seen or disturbed it. There are now four eggs in the nest, and the birds have begun to sit upon it.

It is therefore evident that these redstarts as well as the red-throats had formed a correct idea of the kindliness of their host, that it had taken deep root in their little brains, and that the confidence they showed in us was the result of very attentive, precise, and just observations which they had been able to make upon the inhabitants of my house.—*Translated for The Popular Science Monthly from La Nature.*

SKETCH OF JOHN ERICSSON.

THE arts of marine engineering and naval construction have been revolutionized through the inventions of Captain Ericsson. As is remarked in a passage cited by Mr. F. C. Church, in his biography of him, "in the closing years of his life he could look back upon 'a change in the physical relations of man to the planet on which he dwells, greater than any which can be distinctly measured in any known period of historic time,' and this he had no small part in creating."

John Ericsson was born at Langbanshyttan, in the province of Wermland, Sweden, July 31, 1803, and died in the city of New York, March 8, 1889. His ancestry is traced back to the family of Leif Ericsson, the son of Eric the Red, the Norse discoverer of America. He was also related to Thorwaldsen, the sculptor, who was descended, according to Mr. John Fiske, from the son of Thorfinn Karlsefne, the first white child born on American soil. His father, Olaf Ericsson, was a proprietor of mines; his mother was a daughter of an ironmaster, who was possessed of gifts which,

according to Mr. Church, she transmitted to her sons Nils and John. She used to relate that an old man had prophesied to her father that two boys would be born in the family who would become famous. John manifested an aptitude for constructive work at an early age. As a child he amused himself with drawing, boring, and cutting. A little older, he watched the engines at the mines, copied their models in his drawings, and studied their motions. He traced the first suggestion of his future career to the day when, in his seventh year, he dug a mine a foot deep and made a ladder for the use of imaginary miners. When nine years old he had learned the use of drawing instruments and the art of preparing constructive plans.

In the industrial disturbances occasioned by the war with Russia Ericsson's father lost all his property and was thrown out of business. In 1811 he obtained a responsible position in connection with the construction of the Götha Canal, in which he gradually rose. John in the meantime was improving in the exercise of his rare talents. In the deep forests, to which his father had removed, drawing tools were hard to get. He had a pen and pencil. He made compasses of wood, with needles for the points; contrived a drawing pen out of a pair of tweezers; and made brushes of the hairs of his mother's sable cloak. With these home-made instruments he executed the drawings for a pumping engine to be operated by a windmill.

The best use was made for the Ericsson boys of the limited educational advantages which the region afforded. A governess was furnished them in the years 1811 and 1812. A draughtsman, connected with the work on the canal, taught them how to finish their drawings in a style which rivaled that of engraving. They were given access to the draughtsman's office of the canal company. John exhibited his first drawing to the scale when eight years old, and he learned to sketch maps. One of the superintending constructors of the canal was engaged to teach the boys algebra and architectural drawing. Another tutor "plagued them with lessons in Latin grammar," from whom also John learned "chemistry and many other things," he says, "of great use to me; for instance, how to make and mix colors for my drawings out of materials bought at the druggists for a few cents." The curate at Fredsberg on the Lefsäng was engaged to teach them French. The most distinguished mechanical draughtsman in the country gave them further perfection in his art; and other instructors, drawn also from the professional men engaged on the canal, taught them algebra, field drawing, geometry, and English. While John was naturally disposed to think and act for himself, these lessons tended to promote and encourage his intellectual self-reliance. When a friend spoke to him

with regret of his not having been graduated from some technological institute, he answered that the fact, on the other hand, was very fortunate. If he had taken a course at such an institution, he would have acquired such a belief in authorities that he would never have been able to develop originality and make his own way in physics and mechanics.

When John was eleven years old he and his brother became pupils in engineering of Captain Edström, who had been sent to England to study the most approved methods in canal construction. He was so pleased with their work that he recommended them to Count Platen, President of the Götha Ship Canal. This officer had been shown specimens of what John had done, and, receiving him, predicted that if he continued as he had begun, he would some day produce something extraordinary. When twelve years old John was employed, under the direction of his chief, in drawing profile maps and plans for use on the canal, and to be filed in the archives of the company; in the next year he was assistant to the *niveleur* (or leveler) in charge of the station of Riddarhagen; and in another year, when only fourteen years old, and obliged to stand on a stool to reach the eyepiece of his surveyor's level, he was put in charge of the Rottkilms station, where he had to give directions daily to six hundred men. About this time he became assistant to the chief of the work. While engaged as leveler he made drawings of the Sunderland iron bridge, which Count Platen admired very much. He drew for his private use maps and sketches of important parts of the canal and of the machinery used in its construction, which he began to publish several years afterward, inventing an engraving machine to enable the work to be more speedily done. He found, however, that the machinery illustrated by his drawings was being superseded in the rapid progress of improvement in mechanical construction, and discontinued this enterprise.

In 1820, when Ericsson was seventeen years old, after his father had died, he entered the military service of Sweden, and was appointed an ensign in the Royal Field Chasseurs of Jämtland, and stationed at Frösön, near Ostersund. The step was taken against the protest of Count Platen, and was the occasion of a breach between them. Soon after joining his regiment he was recommended for promotion, but his colonel was out of favor at court, and the recommendation would not have been heeded, had not the Duke of Upland, son of King Bernadotte, pleaded for him. The duke showed his Majesty one of Ericsson's military maps, whereby the promotion was secured, and the king's attention was directed to Ericsson's skill as an engineer. Ericsson was subsequently commissioned to draw maps to illustrate the campaigns of Bernadotte as marshal of Napoleon. He passed the

examination for and obtained an appointment on the survey of northern Sweden, and in connection with that work made detailed drawings of fifty square miles of the country.

On the advice of friends, including the king, who considered his abilities greater than could be adequately rewarded in Sweden, and himself, no doubt, willing to seek a larger field of usefulness, Ericsson in 1826 secured a leave of absence from the service and went to England. He took with him plans, including a flame engine which he had experimented on successfully with wood as fuel, but which was not available when coal was used; and a still undeveloped idea in his mind of a vessel which "it was possible for Sweden to build, and which would render the wooden walls of England of no avail against her." He had intended to resign his lieutenancy, but, overstaying his leave of absence without obtaining an acceptance of his resignation, he was placed in an embarrassing position, from which he was extricated by the intercession of the crown prince; and in October, 1827, he received a promotion to a captaincy and an acceptance of his resignation. The title of captain thus obtained, and a degree of LL. D. from an American university, were the only honors he cared to display to the public, though he had many others equally high.

In the two years, 1828 and 1829, after he went to England, Captain Ericsson completed seven inventions. One of these, a machine for compressing air, was used in clearing one of the Cornish mines of water; another involved the use of artificial draft for steam-boiler furnaces. Sir John Ross was preparing for his second arctic expedition, but not wishing his purpose known, concealed it in ordering the engines of his vessel; and the contractors, Braithwaite and Ericsson, supposing that the voyage was to be of an ordinary character, put in one of these engines with other appendages not adapted to arctic navigation. When Captain Ericsson learned the destination of the vessel, he warned Captain Ross that the engine had not been built for that kind of work and would be useless. His prediction was fulfilled as soon as the vessel entered arctic waters, and the engine was thrown overboard. The principle was, however, retained for ordinary steam vessels, with results quite satisfactory. The third invention was a steam fire engine. The first, an experimental engine, was followed by four others, completed, one of which, sent to Prussia, proved so efficient that the designer received, in recognition of its value, an honorary membership in the Berlin Institute. Another engine, employed in London, extinguished the fires, but was objected to and rejected on account of the quantity of water it required; and it was nearly thirty years before London would have another steam fire engine, inferior to Ericsson's.

In 1829, while it was still undecided whether stationary or

locomotive traction should be adopted for the railway between Liverpool and Manchester, a prize of £500 was offered for the best locomotive. Although five months were given the competitors in which to prepare themselves, Ericsson did not learn of the offer till within seven weeks of the day of trial. Stephenson brought out his "Rocket" engine, with every appointment perfect and tested. Ericsson produced his "Novelty," graceful in design and structure, and with every part planned on sound principles, but built in haste and untested. It suffered two breakdowns in the trial, caused by undetected faults in workmanship; but not before it had passed the "Rocket" and reached a speed of thirty-two miles an hour. Ericsson withdrew it in disgust, and the prize went to Stephenson. But every one admired the beauty of the "Novelty"; the judges spoke of its appearance as being very much in its favor, and commended the ingenuity with which the machinery was so contrived as to work out of sight, and the compactness of its form; and John Scott Russell, the eminent English engineer, wrote in the Encyclopædia Britannica in 1840 that "the 'Novelty' had to be withdrawn through a series of unfortunate accidents which had no reference to the character or capabilities of the engine. And we well recollect that it made a profound impression on the public mind at the time. On the first day of the trial it went twenty-eight miles an hour (without any attached load), and did one mile in seven seconds under two minutes." Two other elegant locomotives were built by Ericsson, but they failed to give entire satisfaction in the working, and this field of construction was left to Stephenson.

In 1830 Captain Ericsson devised the centrifugal fan blower which afterward came into general use on our river steamers; in 1834 he took out a patent for a deep-sea lead, on a principle similar to the one employed in a lead designed by Sir William Thomson. He received a prize from the London Society of Arts for a hydrostatic weighing machine. He exhibited at the International Exhibition of 1852, and received a medal for them, an instrument to measure distances at sea; an alarm barometer which sounded a gong in warning of approaching storms; and a pyrometer which measured temperatures up to the boiling point of iron. He invented an instrument for measuring the compressibility of water; methods of propelling boats on canals, one of which has been applied to the heavy grades of Swiss mountain railroads; a water meter, a centrifugal pump, a file cutting machine, an apparatus for making salt from brine, and numerous applications to the steam engine, many of which came into use, while others were abandoned. He experimented with superheated steam; and Mr. Church says that he designed more than five hundred steam engines.

While he was making all these machines he was also experimenting with designs for a caloric engine. His researches in this direction were begun with the "flame engine" already mentioned. He contributed a paper on the subject to the English Institution of Civil Engineers in 1826; built three engines in 1827 based on the principle of the expansion of air; brought out a completed caloric engine in 1833, to which he applied improvements as his investigations continued; received the Rumford medal in 1856 for his researches into the nature of heat; and, according to Mr. Church, spent in thirty years, including the engines for his caloric ship, more than a quarter of a million dollars in building twenty-seven experimental engines. The caloric system was not successful when applied to the propulsion of large vessels like the Ericsson, although that vessel registered a speed of eight and attained at one time a speed of eleven miles an hour, but for lighter work it has proved very practicable and efficient; the smaller machines have been extensively used, and the inventor derived large profits from them.

The first experiment with the screw propeller was made in 1836 by Captain Ericsson, in conjunction with his friend Francis B. Ogden, of New Jersey, United States consul at Liverpool. A model of the apparatus was built and tested in a public bath. Then a boat forty feet long, propelled by a double screw, attained a speed of ten miles an hour on the Thames. The Lords of the Admiralty were passengers on the trial trip; but seeing was not believing with them, and, while they witnessed the successful performance of the craft, they declared that no vessel could be steered if the power was applied at the stern, and would have nothing to do with it. Captain Robert J. Stockton, of New Jersey, afterward United States Senator, was visiting England at the time on business connected with the Delaware and Raritan Canal, and, witnessing the performance of the propeller vessel, ordered one built for himself and named after him. It was sent across the Atlantic, and when it reached New York the freedom of the city was given to its captain. This vessel was employed for many years in the waters of the United States, and, passing into the possession of the Messrs. Stevens, of Hoboken, N. J., was known as the tug New Jersey till 1866, when, or about that time, it was broken up.

On the invitation of Captain Stockton, Captain Ericsson resigned, in 1839, the position of Superintending Engineer of the Eastern Counties Railroad in England, and removed to the United States. By the aid of Captain Stockton's influence he obtained a commission to build a steam-propeller frigate, the Princeton, for the United States Navy. Before this vessel was finished, in 1844, his screw had been placed in forty-one commercial vessels of the

United States. Another new and valuable principle was introduced in the Princeton—that of applying the power directly to the shaft turning the screw. Ericsson's propellers with direct-acting engines below the water line were also applied in the French frigate Pomona in 1843, and in the British frigate Amphion in 1844. The Princeton was fitted with a twelve-inch wrought-iron gun, forged after Ericsson's designs, and strengthened with bands, which had been tested; and with a heavier gun ordered by Captain Stockton, called the Peacemaker. This gun, when fired—Ericsson's friends claim, against his advice—during a visit of President Tyler and members of his Cabinet to the Princeton, February 28, 1844, burst, killing the Secretaries of State and the Navy, and Colonel Gardiner, of New York.

From the year 1826 Ericsson had entertained the idea of contriving an "impregnable and partially submerged instrument for destroying ships of war," and had a plan matured for it in 1835; and the idea of protecting war engines for naval purposes was as old with him, he wrote, as his recollection. He had become satisfied also that armor plates that a vessel could carry could not be forged which a gun could not be constructed to penetrate if fired directly at them. From these ideas was developed the plan of the submerged vessel carrying a turret, which was embodied in the Monitor. In August, 1861, he proposed to President Lincoln to build a vessel for the destruction of the Confederate war-craft, declaring that his purpose was not private profit but only to serve his country. No settled purpose or idea of what was to be done seems to have existed in Washington; but Ericsson, after presenting his plans, was directed to construct the Monitor according to them, within a hundred days. The result of the first experiment with this vessel constitutes one of the sensational incidents of history. The Monitor's guns were not allowed to be charged in that action as heavily as Ericsson desired—they would have borne, in fact, a charge three times as great as was given them—consequently the Merrimac was not destroyed, as it probably might have been. Nine other monitors were built for the Government by Ericsson and his business associates, of which the Dictator was completed, as he reported to the Navy Department, with a displacement of a fraction of an inch less than he had calculated.

In 1869 Captain Ericsson contracted to furnish the Spanish Government with thirty gunboats after his own designs, for use against Cuban insurgent blockade-runners. They were all afloat within four months, two months before the time they were to be called for by the contract, and half of them had their engines and boilers on board. Several novel features were introduced upon them; they proved admirably adapted to their purpose; and in

recognition of his service the Spanish Government conferred upon Ericsson the decoration of Isabel la Católica.

Captain Ericsson's ideas of a war vessel for submarine work more seaworthy than the monitors were embodied in the Destroyer, which was launched in 1878. "It is an iron vessel, one hundred and thirty feet long, seventeen feet wide, and eleven feet deep, protected by a wrought-iron breastwork of great strength near the bow," carrying a submarine sixteen-inch gun thirty feet long, the muzzle of which projects through an opening in the stem near the bottom, and which is intended to carry a fifteen-hundred-pound projectile charged with three hundred pounds of guncotton. The vessel is intended to attack "bow on," and to discharge its projectile from within three hundred feet of the object of assault. The bill for the purchase of this vessel by the United States, although it passed the Senate in 1885, failed to become a law.

"Three distinct purposes," says Mr. Church, "are apparent in Ericsson's labors: first, to improve the steam engine and extend the scope of its application; next to discover some more economical and efficient method for changing the mode of motion we call heat into the mode of motion we call power; third, to force the great maritime nations to declare the ocean neutral ground, by making naval warfare too destructive a pastime to be indulged in." We have seen how he worked out the first of these ideas in his numerous adaptations of the steam engine, and the third in the monitors and the Destroyer. In trying to make the second idea practical he devised the caloric engine and devoted many of the later years of his life to the investigation of the solar heat and of methods of converting it into a direct source of mechanical power. He devised and constructed a solar engine in 1883, which was described and illustrated in Nature (Vol. XXIX, p. 217), and labored until within two years of his death to improve and perfect it. In his description of this engine he showed that with reflecting plates of one hundred and thirty by one hundred and eighty inches and a steam cylinder of six by eight inches he could obtain a speed of engine of one hundred and twenty turns per minute, with an absolute pressure on the working piston of thirty-five pounds per square inch. He devoted himself regularly and, except for the daily walk for his health, unremittingly to his work. Fitting up his office and workshop in Beach Street, New York, he occupied his whole time in investigation, experiment, and construction, refusing to be interrupted, and shutting himself out from general visitors. He was a man of great physical strength, and some remarkable stories are told of his feats in lifting. In one of them, when in youth he raised a weight of six hundred pounds, he thought he overstrained himself, and

he ascribed to it certain pains in his back from which he suffered.

He participated eagerly in physical sports, was expert in Swedish gymnastics, was one of the best shots, the best leaper, and the champion wrestler in his regiment, and was famed as an athlete, skater, and swimmer. Mr. E. H. Stoughton, formerly minister to Russia, is said to have surprised him once at sixty years of age standing on his head, to prove that he had not lost his agility. He was a man of unbounded benevolence, and never refused the petitions of those who came to him in need.

While his literary works were not numerous, Captain Ericsson was a writer of force and ability, with imaginative faculties that might have been developed under cultivation. In his youth, and while engaged in his surveying work, he sometimes, he says, "wrote poetry to the wonderful and enchanting midnight light of Norrland. Connoisseurs often doubted that it came from the second lieutenant and surveyor among the mountains." His communications to the periodical press on the subjects in which he was interested were clear and vigorous, and always acceptable.

He was a man of intense patriotism, which he manifested equally toward his native land, although he never returned to it, and the United States, the country of his adoption. In his studies and inventions he had always in view the protection of Sweden against the aggressive stronger powers; and he gave the fruits of them ungrudgingly to the United States—not always insisting upon his reward as persistently as he had a right to do, and too often not receiving it, or receiving it at the expense of delay and trouble not creditable to our Government. His gifts to Sweden, after he became prosperous, were numerous and bountiful, and included contributions for the relief of sufferers from famine and from a fire at Carlstad, and for a benevolent fund for the aged miners and miners' widows of his native province; a subscription to the Royal Library of Stockholm; the guns for the first Swedish monitor; and a gunboat for coast defense. In 1867 the miners of his native region erected in front of the house in which he was born, at their own expense, a large granite monument, bearing the inscription, in Swedish, "John Ericsson was born here in 1803."

We are very largely indebted for the detail of the facts concerning Captain Ericsson's inventions to the excellent biographical articles concerning him by Mr. William C. Church, which were published in Scribner's Magazine in 1890.

EDITOR'S TABLE.

THE BEARING OF THE DOCTRINE OF EVOLUTION ON SOCIAL PROBLEMS.

THE following very pertinent questions were proposed for discussion at the World's Congress of Evolutionists, held during the last days of September in connection with the Columbian Exposition:

"Does the doctrine of evolution in its sociological aspects offer wise suggestion for the solution of the grave social and economic problems of our time?

"What in accordance with such suggestion should be the next step taken in our own country looking toward the solution of these problems?"

At the moment of writing we are not in possession of the result of the discussion thus provoked; but, as the questions must be of interest to very many of our readers, we propose to attempt such an answer to them as our brief limits permit.

The doctrine of evolution in its broadest aspect is simply that doctrine which teaches us that everywhere throughout Nature there are action and reaction between organisms and their environments; that where the result of this action and reaction is increasing heterogeneity and complexity of the organism, with more complete and various adjustment or adaptation to the environment, a process which may be called evolution is in progress; and that when, on the other hand, the result is the obliteration of special adaptations and combinations and a return toward simpler modes of organization, a process of dissolution is in progress. It is a doctrine which proclaims the supremacy of natural law, and which keeps prominently before the mind the necessity of an efficient cause for every change that takes place. It thus introduces into the realm of organic Nature and into the moral and social spheres the Newtonian principle that the direction of motion can not be changed without the application of force. The mind that has accepted the evolutionary view of things has done with vain superstitions and idle credulity. It feels no less than before the vastness and mystery that surround human life and limit human thought, but it has lost all appetite for what may be called the vulgar marvelous—that toward which childish minds of every age go so eagerly forth.

When, therefore, we try to bring the doctrine of evolution to bear on the social and economic problems of our time, the first thought that occurs to us is that the so-called problems are aspects of the change that society is undergoing in its progress toward higher organization. That the process in the midst of which we live is one of evolution and not of dissolution is evident by many signs. What we see is the effort of the different classes and elements of society to achieve the establishment of satisfactory mutual relations, or, as we may otherwise express it, to discover and give effect to a *modus vivendi*. That this involves occasional conflict is just what might, on general grounds, have been anticipated. The market price is not fixed without a good deal of "higgl ng," and precisely the same process applies to the adjustment of social relations. "Higgling" may not be a beautiful thing to witness, but it does its work in the fixing of prices much better than would a competition in altruism, which could only lead to utter confusion. The evolution philosophy would therefore suggest to us extreme caution in interfering at all with the process which we see at work. What is manifestly necessary, however, is that no one individual or group of individuals should be al-

lowed to exercise arbitrary and irresponsible power in the effort to advance their claims. Power, in the last resort, belongs to the community as a whole, and no man or group of men should be encouraged for one moment to think that he or they can be allowed to usurp the authority of society. There is no "higgling" if one of the parties to the bargain takes a club and forces the other to accept his price. Society should be the sole club-wielder, and, while slow to wield it in general, should be quick to wield it upon those who would take the club out of its hands. It is bad for the individual not to insist upon his rights; but for society not to insist on its rights is absolutely fatal.

In the popular mind the theory of natural selection is largely identified with the doctrine of evolution, and many are impressed by the work of Darwin who have but a scant knowledge or appreciation of that of Spencer. Darwin was buried in Westminster Abbey, but whether an equal honor awaits the author of the Synthetic Philosophy is perhaps doubtful. The theory of natural selection, however, far from being the whole of evolution, is only a subordinate aspect of it. At the same time, if we would gather the practical lessons of the evolution philosophy, the views elaborated by Darwin claim our serious attention. We have learned from him how Nature is continually *selecting* those who are to carry on the great chain of life. Not every one who is called is chosen, which, interpreted by Darwin, means that not every one who is called *into* life is chosen to carry on life. Far from this, the vast multitude of living things meet untimely death, and go to aid, either actively or passively—actively if they minister to their sustentation, passively if by their absence they lessen the demand on food supplies—the lives of the survivors. There is perhaps no greater or more serious problem confronting society to-day than this: how to pay just heed to the above law without injury to our own moral sensibilities and particularly to our sense of the sacredness of life. It is impossible to doubt that the law on which the well-being of every other animal species depends must be vindicated in the case of the human species also; and yet the very fact that we are sensible of the problem before us shows that we are called to solve it in a manner suitable to our higher intellectual and moral development. As every one is aware, there is at present an important controversy in progress between Mr. Spencer on the one hand and Prof. Weismann on the other, upon the question as to whether modifications acquired by an organism during the course of its individual existence are transmissible by inheritance. The discussion is not one into which we can enter; and we only refer to it for the purpose of remarking that, though it seems to touch a vital point in the doctrine of evolution, the great fact of evolution remains unassailable. The practical difference between one view and the other is that, if Mr. Spencer is right, a larger scope seems to be opened for educative effort, and more encouragement for such effort is afforded; whereas, if Prof. Weismann is right, the one all-important principle to keep in view, if we would preserve society from degeneration, is that of selection of stocks, seeing that an inferior individual, however much we may improve him personally by education, must, if he have progeny, transmit, not the qualities imparted by education, but those bestowed upon him by Nature at birth.

The doctrine of evolution thus shows us the necessity for struggle in the settlement of the bases of society, and it indicates, in a general way, how that struggle should be carried on, namely, by a firm and decent assertion of individual rights, and the acceptance by each and all from time to time of such compromises as circumstances prescribe. Should there be, in any given society,

such a relaxation of the moral fiber of individuals as would lead them to forego their just claims, in presence of violent demands unsupported by reason, there would be great cause to fear that the society as a whole would also abnegate its just authority and thus leave the way open for lawless, ambitious, and anarchic forces. If not the greatest, the surest service, therefore, which any individual can render to the community in which he lives is to stand on his rights, not in his own interest or for his own sake merely, but in the interest and for the sake of all his fellow-citizens; for in this way others will be encouraged to stand on their rights, unjust pretensions will be discouraged, and the whole fabric of society strengthened. We say this is the surest service an individual can render; because there is no doubt whatever as to the beneficial results of such a line of conduct, whereas all purely altruistic measures are of more or less uncertain tendency. This is shown by the frequent failure of benefactions to accomplish the purposes for which they were intended, or, we may even say, their frequent perversion to purposes entirely opposed to the objects in view. It requires a vast amount of wisdom to be generous without doing more harm than good; but, in practicing and insisting on justice, no risk whatever of doing harm is incurred.

If there is any one thing in the way of positive effort which the doctrine of evolution seems clearly to prescribe as advantageous, it is the exposition of the doctrine itself to all who are capable of understanding it, so that there may be a general comprehension of the true goal of society and of the conditions necessary for unimpeded social progress. How few persons, comparatively speaking, understand that justice is the one vital principle, the one essential condition of social welfare! How few persons are prepared to make allowances for the necessary imperfections of human society, or to see in what is commonly regarded as evil a preparation for higher good! How few have the balance of mind that enables them to place a true value on the nostrums of would-be reformers, who undertake to make you a new society if you will only allow them to pass a law or two! How few have a true and reasoned faith in the possibilities of social progress! In regard to all these matters there would be a great increase of public intelligence if the doctrine of evolution, with all that it implies, were as earnestly and industriously taught as certain other views of life, which appeal more to emotion than to reason. The doctrine of evolution stands to-day for the scientific view of life, and, the more that view can be brought home to the masses, the surer will be the foundations of the state, and the more rapidly and happily will the stages that yet separate us from a condition of perfect social health be accomplished.

SCIENCE AT THE COLUMBIAN EXPOSITION.

The great Fair at Chicago marks the utmost achievement of the kind that the world has beheld, and probably the last effort which America will see on the plan of universal inclusion. Science and art in these latter days have become so broad in development, so minute in specialization, that from sheer unwieldiness it would be scarcely possible to repeat the programme of Chicago, expanded as it inevitably would be in the flight of time. In Great Britain the universal exhibition has been differenced into a series of expositions of fisheries, inventions, "healtheries," and so on, a sensible plan which America is likely to copy. In displays so vast as those of Jackson Park the ordinary visitor can bestow no more than a passing glance on rows upon rows of cases, often filled with objects of beauty and high interest. Those who have been instructed by the Fair are those who went to study a particular feature of it, or the

fortunate few who have been able to devote months to its examination as a whole. And yet something will be lost when the days of universal exhibitions are past. There is a cross-fertilization of ingenuity illustrated only when displays of the utmost diversity are brought together. In Machinery Hall is the familiar festoon of perforated cards guiding the Jacquard loom; in the Federal Building is a new indexer for libraries identical in principle; in the Transportation Building is an extensive array of the maps whose marginal letters and figures indicate the particular square in a chess-board where a sought town or village may be found; in Machinery Hall the compositor is superseded by a machine which adopts the same principle in casting type from a manuscript reduced to perforated symbols.

In so far as there may be a science and an art in disposing a universal exhibition the Fair at Chicago evinces a distinct advance. Mr. G. Brown Goode, of the National Museum at Washington, defines an efficient educational museum as a collection of instructive labels, each illustrated by a well-selected specimen. Add to this the intelligent custodian to answer inquiry or to show a machine or an apparatus at work, and from museums are born an exhibition interesting and informing. Something else, however, is necessary—an exhibition must mainly, but should never wholly, depend upon the good will, the enterprise, or the generosity of individual exhibitors. Wherever needful, it should be made comprehensive by the board of management buying or hiring what they can not borrow. Because of the strike at Homestead last year there is at Chicago no adequate display of the iron and steel industry which has in America made so remarkable progress within recent years. In the Electricity Building there is no display of Edison's kinetograph, an instrument which nearly two years ago had been brought to the point of reproducing by instantaneous photography with remarkable fidelity the visual impressions of motion.

With abundant means, with trained skill and comprehensive purpose, much the best group of exhibits at Chicago is presented by the national departments, in the Federal Building. Within its appointed limits the displays in the Anthropological Building are as admirable in arrangement as those of the Federal Government; here the debt is mainly due to the devoted labors of the officer in charge, Prof. F. W. Putnam, of Harvard University. In the Agricultural Building the State experiment stations, which owe their origin to Prof. W. O. Atwater, in their systematic array of appliances and results show how much the farmer is profited by his new partnership with the man of research. Agriculture, it would seem, in certainty of results, is fast taking on the conditions of manufacture. Many of the industrial exhibits in excellence of arrangement vie with those formally scientific; as a type of these displays that of the Standard Oil Company deserves particular mention. In the same building, that of mining industry, the western gallery bears a small but capital exhibit of aluminium, from its ore, bauxite, through the processes of the electrical furnace until pure metal is derived: all the principal uses of the metal are illustrated; these are accompanied by specimens of its most valuable alloys. This exhibit is in striking contrast to others within the same walls—displays some of them as ill assorted as the contents of an auction room.

In designing several of the State buildings at the Fair they were contrived to pay a double debt: they illustrate noteworthy styles of architecture, or reproduce famous structures, as well as serve as show places and club houses. In much the same way it would have been easy for, let us say, the Shoe and Leather Building to have exemplified the slow-burning construction for factories which in the Eastern States has so much reduced the fire tax.

These are not times when inventors or manufacturers wait for an exhibition to give the world its first view of their work; hence, in the Electricity Building, for example, there is little of novelty, and yet in its mass and variety the contents of the great hall and galleries are most impressive. Here are shown how, in the seventeen years since the Centennial Exhibition, electricity has passed from the experimental laboratory to become the most versatile and powerful servant that industry and domestic economy know.

Within the past two decades Photography has stridden along almost as fast as her sister Electricity. In an inconspicuous booth in the gallery of Liberal Arts is an exhibit without an attendant, lacking adequate labels, and yet withal marking an epoch in the application of scientific research to this art and industry. The display presents photography in colors, an achievement due to Dr. H. Vogel, of Berlin. In observing the fugitiveness of some aniline dyes, it struck him that the very sensitiveness to certain rays of the spectrum which rendered the dyes as such worthless, meant a photographic quality of the first importance. Experiment proved the soundness of his surmise, and orthochromatic and color photography were born. In pure and applied chemistry Germany, as her show-cases at Chicago amply attest, is far in the lead. In Germany practice and theory have long ceased to look askance at each other, and the lesson should not be lost on America, for theory and practice have at last arched toward each other until at many points they touch, with the effect that both are vastly the stronger. To-day the observer can pass to prediction, the experimenter can build to order a molecule, a flower, a cereal, or a beeve. The convincing word of Germany to America is that to begrudge the means for original research is simply to withhold the seed-corn of progress. But America, too, has something to teach. In science her most worthy and characteristic display is that of instruments of precision. The dividing engine of Prof. W. A. Rogers, the diffraction gratings of Prof. H. A. Rowland, the parallel planes in glass of Mr. J. A. Brashear—with a limiting error of one millionth—the lenses with perfect color correction of Prof. C. S. Hastings, mark a distinctively American field of attainment and make clear why this country divides with France the leadership in modern astronomy, and in apparatus for the most refined measurement has no rival. It is gratifying to see at the Fair the magnificent new telescope for the University of Chicago, the refractor for which, forty inches in diameter, is the largest in existence.

In education the exhibits at the Fair, repetitious though they are and often poor in quality, show progress. The large spaces given up to manual training, to instruction in sewing and cooking, to the all-round development of the senses, abundantly prove that the old and wasteful clerkly instruction has its hat in its hand and is moving toward the door. In the Children's Building the kindergarten and kitchen-garden classes are giving admirable lessons not only to many little people but to uncounted thousands of interested parents. At many other places in Jackson Park how sound education brings out an intelligent interest in every-day work and duty is attractively demonstrated. Take for example the Rumford Kitchen, where with the minimum of toil and offense a meal both palatable and nourishing is cooked at a cost of less than five cents. Mr. Edward Atkinson, who leads in this branch of household economy, is desirous that the State experimental stations should add courses in cooking to their instruction. Why, he argues, should we be anxious that food stuffs be produced with the utmost saving of labor, and then in the cooking waste them one half? For education conceived in its broadest reach one of the

most significant services has been rendered at the Fair by the psychological exhibit and laboratory, over which Prof. Jastrow presides, in the Anthropological Building. Here, amid the most extensive collection of appliances ever brought together in America, quantitative tests of faculty are made: the effect of this new science of experimental psychology on education must be to sift out good methods of instruction from bad, and in the fullness of time to awaken and direct in the individual mind the ambitions which to-day either remain unaroused or ignorantly run riot.

In some respects the most audacious and the least satisfactory part of the programme at Chicago has been the Auxiliary Congresses. Assembled seven miles from Jackson Park, in a building directly abutting on a noisy railroad, filled with smoky and dusty air from locomotives and factory chimneys, the sessions have often been too much for human endurance. With utterly inadequate means the president, Hon. C. C. Bonney, has been unable to provide fitting attendance, or to give suitable publicity to the daily proceedings. Nevertheless, despite shortcomings on every hand, the Art Institute has during the past five months given a hearing to nearly every eminent American teacher, and it has opened its doors to Prof. von Helmholtz, and to other men of science from abroad scarcely less illustrious.

LITERARY NOTICES.

Seventh Annual Report of the Commissioner of Labor, 1891. Carroll D. Wright, Commissioner. Washington: Government Printing Office. Pp. 841.

It is the duty of the Department of Labor to provide for reports, at intervals of not less than two years, on the general condition, so far as production is concerned, of the leading industries of the country. A shorter period is prescribed than that fixed for the taking of the census, in the belief that a fairer average would be shown in the run of consecutive reports of short terms than could be obtained from reports made every ten years, any two or more of which might be, relatively to the intervening years, exceptional ones. Two years from the organization of the department, however, brought it to the census year 1890, when its report would be merged in or superseded by the census returns; so that it was not deemed expedient to establish the system of reports contemplated till 1892. A method has accordingly been under organization for securing proper information relative to the leading industries of the country which will enable the public to make comparison with the census reports of 1890 as to the movements of production. The department was represented at the Congress on Accidents to Labor held in Berne, and at the Congress of the International Statistical Institute, held at Vienna, in 1891; and it is believed that the experience of American statisticians with reference to labor statistics and the influence of the American representatives prompted the introduction and unanimous adoption of the resolutions of the institute recommending the adoption of similar measures in other countries. The present report, the seventh, continues the investigation of the cost of production in leading countries of articles dutiable in the United States, which was begun in the sixth report and applied in it to iron, steel, bituminous coal, coke, iron ore, and limestone, extending it to the textiles and glass. The facts inquired into include the different elements of cost or approximate cost, the wages paid in the industries involved, the comparative cost of living, the kind of living, etc. All feasible means are used to secure complete information, and, in order that no establishment may be embarrassed by having its inner concerns exposed to the public, the names of all companies and persons who have contributed to the value of the investigation are carefully kept out of sight. The department has aimed to make a judicious selection both as to representative concerns and representative facts; but it does not presume to flatter itself that it has given everything that everybody will want. Two hundred and seventy-eight establishments are represented in the tables, of which forty-nine are

in Europe. The articles reported upon are cotton textiles, cotton yarns, woolen and worsted textiles, woolen and worsted yarns, linen textiles, silk textiles, window glass, green-glass bottles, flint-glass bottles, and lamp chimneys.

The Shrubs of Northeastern America. By Charles S. Newhall. New York: G. P. Putnam's Sons. Pp. 249. Price, $2.50.

The author has already published The Trees of Northeastern America and The Leaf-collector's Handbook, and is preparing The Vines of Northeastern America—the four constituting a series of work which the botanist, the admirer of native plants, and the possessor of a home to be adorned, can not fail to find useful and acceptable in every way. The purpose is to furnish means by which one strolling in the woods can easily recognize the woody plants he meets, and information concerning their adaptability to planting in the house-grounds; or to introduce the many who have no technical botanical knowledge to the author's "friends, the shrubs." The shrubs described are those which are found native in Canada and the United States east of the Mississippi River and north of the latitude of southern Pennsylvania; and with them, the more important of the introduced and naturalized species. Besides the botanical descriptions—which are clear, easy, and satisfactory—and one hundred and sixteen illustrative plates, there are given a list of families and of genera, directions and a key to the signs used, guides to the shrubs by flower, by leaf, and by fruit, an explanation of terms, a glossary, a list of shrubs worthy of cultivation, and an index to the shrubs.

Homes in City and Country. By Russell Sturgis, John W. Root, Bruce Price, Donald G. Mitchell, Samuel Parsons, Jr., and W. A. Linn. New York: Charles Scribner's Sons. With One Hundred Illustrations. Pp. 214. Price, $2.

The papers in this volume relating to city homes are partly historical, and treat of the evolution of the plans from the first attempts to adapt room space to narrow lots, to the modern styles. The first one, by Mr. Sturgis, on the City Homes in the East and South, relates to houses in New York, Boston, Philadelphia, Baltimore, Richmond, Va., etc. The views and plans show how the New York house, and still more the Boston house, were cramped by the small size of the lot and the high price of land; while the houses in the more southern cities, Philadelphia, Baltimore, and Richmond, with greater freedom of space, were expanded, and much more convenient and comfortable; and an almost endless variety prevails in the cities farther south. Mr. John W. Root begins his account of the city house in the West by showing how the device of the "balloon frame" has assisted in the spread of settlement and civilization; for almost any one can put up that kind of a house, with the simplest implements, in a short time and at comparatively little cost; and it resists the high winds very well too. The younger Western cities are more than half built of such houses; and they are beneficial to the city's future and to its architecture, for because of them "every old Western city must be almost entirely rebuilt, and this under modern and enlightened auspices, as if it had been devastated by a great fire or cyclone. . . . It certainly presents possibilities to the architects of the West such as have never been given to any other groups of men." On the other hand, the balloon-framed house can never become a landmark, or a link in the architectural development of the country. Western city houses are marked by the absence of blocks like those of the Eastern cities, by the tendency toward greater enlargement and importance of the living and dining rooms at the expense of the parlor and living rooms, and by their openness. The outlook for Western city houses seems to be promising. The architecture is free from the bondage of architectural tradition, and among the various rival cities dominant fads are likely to become less common, and problems will be more generally determined by the nature of the case. In the subject of The Suburban Home, Mr. Bruce Price has a theme on which, regarding the colonial houses, the old country houses, the transitory styles of the later past, the present styles, and their tendencies, he might write well for an almost indefinite length. He satisfies himself with considering chiefly the more meritori-

ous styles of the present. The old colonial houses are considered as in all "the best examples built upon classic lines, with a classic base for all their details and classic feeling in all their outlines," but the author concludes that "in the planning, designing, and building of the moderate-cost suburban villa of to-day the American architect has no equal. His work (that is, his best work) is well above and beyond any period of the school anywhere." A chapter by Donald G. Mitchell on Country Houses follows—a theme which was congenial to the author's taste, and is treated by him as if it were, and is not in disaccord with Mr. Price's Suburban Houses; for while Mr. Mitchell insists the more emphatically that his country house shall be a real home, Mr. Price evidently regards his suburban house in the same light; but Mr. Mitchell's houses are all, or nearly all, old-fashioned and also old. The best treatment of Small Country Places is described by Samuel Parsons, Jr., and the Advantages and Operations of Building and Loan Associations are explained by W. A. Linn.

A Handbook of Invalid Cooking. By Mary A. Boland, Instructor in Cooking in the Johns Hopkins Hospital Training School for Nurses. New York: The Century Company. Pp. 323.

This volume has an attractive aspect, more than a *soupçon* of science, and a flavor of good sense. It is intended to fill a need in the training of nurses for more exact direction in cookery, for some knowledge of the chemistry involved, and for a better comprehension of the precautions necessary to secure healthful food. The first part is devoted to preliminary lessons. These deal with chemical and physical changes, the composition of the body, the general constituents of food, and the important topics air, water, milk, digestion, and nutrition.

In the dissertation on milk, directions are given for testing its acidity, finding its specific gravity, per cent of fat, and methods of sterilization are carefully explained.

In the article on nutrition it is stated that the noblest thoughts and most original ideas do not come from an underfed or dyspeptic individual. This certainly ought to be the case, but the shades of Carlyle, Heine, and a host of their ilk would confront us if we affirmed this to be a matter of fact. If, as the author claims, material substances produced as exact results in the chemical physiology of the body as they do in the laboratory, we should understand many metabolic processes that are now inexplicable. Starch and albumin sometimes remain starch and albumin in spite of all digestive juices to the contrary. When the nerves cry "Halt!" the solvents and acids obey. We recognize this inhibitory action if we follow the suggestion to "serve chocolate in dull red." By pleasing the nerves of sight, we strive to put the body in good nervous condition. It is, however, acknowledged that "it can not be said that any particular kind of food will ultimately produce a poem!"

The second part of the book offers a collection of recipes and *menus* suited to invalids, with special consideration of serving, feeding of children, and district nursing. The recipes are well chosen and, for the most part, clearly given. In the introduction the author complains that the majority of cook-books do not furnish intelligible aid, and it is sad to see that she does not improve upon their example. Three recipes for cake are given, and two of these direct the use of an ingredient whose quantity is not mentioned in the formula. In addition to this, it is doubtful whether unfledged cooks will handle successfully unmixed soda and cream of tartar; a good baking powder is much safer and simpler.

There are many hints for gratifying æsthetic tastes in the article on serving. In the feeding of children the naïve question is asked why a child should thrive best upon mother's milk, and it is answered that it is, no doubt, because micro-organisms are found in cow's milk. Sterilized milk may reduce the chances of disease a hundred-fold, yet it can not be adapted to a human child as well as the fluid provided by the cunning chemistry of Nature. As well introduce artificial sap into a flower and query why the tints are not true. This leads us to what we deem an important omission in the book—there is no chapter on the nourishment of mothers. If mothers were adequately and properly fed, the preparation of artificial food for infants would need little attention.

A number of useful lists are appended to the book, including the bibliography, apparatus needed by a cooking school, charts on the composition of foods, and an index.

A Clinical Study of Diseases of the Kidney. By Clifford Mitchell, A. M., M. D. Chicago: W. J. Keener, 1891. Pp. 432. Price, $3.

This is a volume intended for a professional audience solely. It has been written, the author states, with particular reference to the bearing of uranalysis upon the diagnosis and treatment of renal diseases and associated disorders.

The recent literature of the subject, particularly that referring to the toxines contained in the urine of persons either in good or bad health and their influence on the organism, is but cursorily referred to; and the pathology in general seems too meager for a work of this character. The author has not been an original experimenter in the field treated of by his work, rather contenting himself in clinically determining the efficacy and truth of the observations reported by others. He has quoted from many of the more recent writers on this subject, and that portion of his work devoted to dieteties and hygienic treatment is very satisfactory. His therapeusis is that of what is called the homœopathic school, and we do not believe that the text-books of homœopathy could more carefully or efficiently discuss the subject.

An Introduction to Practical Bacteriology for Physicians, Chemists, and Students. By Dr. W. Migula. Translated by M. Campbell. New York: Macmillan & Co., 1893. Pp. 247. Price, $1.60.

It is intended that this little volume should serve as a practical guide for a short laboratory course in bacteriology. The apparatus necessary for bacteriological research is described, and instructions are given for examining living bacteria, for preparing nutrient media, for making plate or tube cultivations of micro-organisms, for cultivating these organisms at high temperatures and also without the access of air, for staining the organisms and their spores, and for mounting. Certain of the more important microphytes are described in order that the student may familiarize himself with them. It is not intended that the volume should supplant the larger and well-known text-books on this subject, and it seems that its practical character fits it for a guide for students desiring a knowledge of the elementary principles of this interesting and important topic.

The Soil in Relation to Health. By H. A. Miers, M. A., F. G. S., and R. Crosskey, M. A., D. P. H. New York: Macmillan & Co., 1893. Pp. xvi–135. Price, $1.10.

The object of the authors has been to prepare a work that will give information on the principles of geology in so far as they concern sanitary science. There is a brief review of the origin of rocks, of their decomposition, and of the formation and distribution of soils. The relation of humus and micro-organisms is then discussed, attention being called to the soil being a habitat for pathogenic micro-organisms and to the necessity for preventing soil infection thereby.

The distribution of water in the soil is described, the subject of subsoil water affording an opportunity of presenting Pettenkofer's theory that, as the authors truly state, has not been confirmed. Sufficient reference is made to the relation between the dampness of the soil and the prevalence of phthisis, though the authors seem unaware of Bowditch's pioneer work in this matter.

There is a chapter on the constituents of water derived from the soil, and the influence that certain of these constituents exercise upon the prevalence of certain diseases.

The chapter on the relation of the soil to the air considers not only the movement of ground air, but also the influence of specific heat, radiation and absorption, conductibility, and color of the soil upon the climate.

The final chapter, on the geographical distribution of disease, very properly calls attention to the fact that while disease maps are of great value in indicating the geographical distribution of disease, they can not be used as maps illustrating the geological distribution of disease until statistics are grouped by similar geological areas where the other conditions are absolutely uniform.

There are several errors in the chapter on humus and micro-organisms. It was Laveran, not Marchiafava and Celli, that discovered

the *Hæmatozoon malariæ;* and no bacteriologist or pathologist attaches any importance to Tommasi-Crudeli's alleged *Bacillus malariæ.* The typhoid bacillus was discovered by Eberth, not Gaffky, who simply confirmed in 1884 Eberth's discovery and announcement made in 1880. Nor did Dr. Klein discover the *Bacillus pneumoniæ* in 1888, as Friedländer had made pure cultures of these organisms in 1883. In fact, the bacteriology of the volume has been written by a person having a very limited acquaintance with the subject. No reference is made to Miquel's, Adametz's, Beumer's, Maggiora's, Fränkel's, Giaxa's, Proskauer's, Manfredi's, and Fülles's investigations of the relation of micro-organisms to the soil.

While the book might have been more complete, it is still sufficiently extensive to be of great use to any student of sanitary science.

The Disease of Inebriety from Alcohol, Opium, and other Narcotic Drugs. Arranged and compiled by the American Association for the Study and Cure of Inebriety. New York: E. B. Treat. Pp. 400. Price, $2.75.

The association named above was organized in 1870, and has a membership composed of physicians connected with asylums for inebriates, and other persons interested in the study of the drink problem. Its cardinal doctrine is that inebriety is a disease, and is curable as other diseases are. It further postulates that all methods hitherto employed for the treatment of inebriety that have not recognized the disordered physical condition caused by alcohol, opium, or other narcotics have proved inadequate in its cure; hence the establishment of hospitals for the special treatment of inebriety, in which such conditions are recognized, becomes a positive need of the age. The association has been in the habit of holding annual and semiannual meetings, in which a large number of papers have been presented, read, and discussed. Six volumes of Transactions were issued, and the Quarterly Journal of Inebriety was established. Its special work has been to gather and group the scientific literature of the subject and make it available for future study. In addition to this literature many members of the association have published volumes on the subject; valuable papers have appeared in this country and Europe. Many of these works having passed out of print, the secretary of the society, Dr. T. D. Crothers, was authorized to prepare a volume to contain the most reliable conclusions and studies of eminent authorities on all phases of the disease up to the present time. In this volume are discussed the etiology, pathology, treatment, and medico-legal relations of inebriety. The selections have been gathered from more than five thousand pages of printed matter published in the Journal and Transactions, and are from papers which have not appeared elsewhere, and hence will be new to most physicians. But it is acknowledged that, while the facts are very numerous and startling and fully sustain the principles of the association, they are not yet sufficiently studied and generalized to be accepted as absolute truths.

Missouri Botanical Garden, Fourth Annual Report. St. Louis: Published by the Board of Trustees. Pp. 226, with 23 Plates. Price, $1.

While no extensive improvements have been undertaken at the garden during the year, the liberal appropriations made for its support have been judiciously expended, and the accounts show a handsome surplus of funds. The library contains now 11,455 books and pamphlets, and the herbarium 203,000 sheets of specimens. The number of visitors to the grounds has considerably increased as compared with previous years; and so far as could be gathered from their remarks, they have shown an appreciation of the improvements that have been made, especially of the more natural grouping of the plants, and of the addition of large specimens of cacti, yuccas, etc., from the arid regions. The last include a number of representatives of characteristic species from the dry districts of Texas, Arizona, and California. The additions to the herbarium have consisted of the current American collections, about three thousand duplicates from the herbarium of the late John Ball, a set of the valuable *Exsiccatæ* of the Austrian flora, given by the Vienna Museum, and many smaller collections and single specimens presented by correspondents. A card index to the species of plants described and figured in works at the garden has been begun; and

the large collection of pamphlets has been put in shape for permanent preservation. Dr. E. Lewis Sturtevant has presented to the garden his extensive and valuable collection of specimens, manuscripts, and illustrations, largely in color, of the genus *Capsicum*, on condition that the genus should be studied with reference to an ultimate monograph of the wild and cultivated forms; and preparations have been made to supply living material for this study. He has further presented his entire botanical library, including the scrapbooks of his own writings and his manuscript notes on edible plants, on condition that he enjoy the use of the books during his life or so long as he wishes them. This library is said to be the most complete and valuable American collection of pre-Linnæan botanical books. The course of study for garden pupils has been shortened to four years, without omitting any of the manual work or any of the studies originally included. Undergraduate engineering students have been secured in the School of Botany for a study of the histological and other means of distinguishing timbers. The volume of the report contains the three regular anniversary publications—the Flower Sermon, which was preached by the Rev. Cameron Mann; the proceedings of the Banquets to the Trustees of the Garden and to Gardeners, Florists, and Nurserymen; a list of Plants collected in the Bahamas, Jamaica, and Grand Cayman; and Additional Notes on Yuccas and their Pollination, by Prof. Trelease, to which most of the twenty-three photogravure plates are illustrations.

Household News. Monthly. Edited by Mrs. S. T. Rorer. Philadelphia: Household News Company, Limited. Price, $1 a year.

The first number of this new household magazine was issued in July. Its editor is the head of the Philadelphia Cooking School and author of a successful cook-book, besides smaller special manuals on Hot Weather Dishes and Canning and Preserving. Cookery, Mrs. Rorer's specialty, occupies most space in the magazine. Under this head in the first number is a series of seventeen bills of fare, with explanations of their novel features, an account of the corn kitchen at the World's Fair presided over by Mrs. Rorer, answers to inquirers, and miscellaneous recipes. The Department of Diet and Hygiene, in charge of Dr. Charles M. Seltzer, contains a leading article and answers to inquirers. Dr. Henry Leffmann, widely known as the author of books on chemical and sanitary subjects, has a department of Household Chemistry, to which he contributes an article on Water in the Household. The Nursery Department is under the guidance of Dr. D. J. Milton Miller, physician to the Children's Hospital and to the Episcopal Hospital in Philadelphia. Other departments are the Kindergarten, conducted by Mrs. M. L. Van Kirk and Miss M. G. Clark; Decoration, by Mrs. Hester M. Poole; Architecture, by Isaac Pursell; and Literature, by Miss Elizabeth Carpenter. A department on the Nurse is to be added. The field of dress is left to magazines devoted exclusively to that subject. There seems to be no room in this periodical for the trash that is too common in so-called "ladies' journals." Its tone is eminently practical, and as there are plenty of housewives who prefer sense to nonsense it has good prospects for generous support.

Soap Manufacture. A Practical Treatise on the Fabrication of Hard and Soft Soaps, etc. By W. Lawrence Gadd, F. I. C., F. C. S. New York: George Bell & Sons (Macmillan & Co.). Pp. 218. Price, $1.50.

There is probably no manufactured article that is used more generally and is of more importance in the household than soap, and yet there is perhaps no substance about which the ordinary consumer knows so little, either as regards composition, methods of manufacture, or adaptation to its various uses. The prevalence of the minor forms of skin diseases, for example, is very general, and there is little doubt that many cases are due, in part at any rate, to the use of improperly prepared soaps, while others are rendered more serious by applications of some of the various medicated soaps, which are so numerous, and often of no medicinal value.

The first chapter of the book introduces the reader to the chemical reactions in soap-making, a knowledge of which is necessary for understanding the subsequent processes, and also gives a few words on the antiquity of the manufacture of soap and its growth as an industry.

The next chapter, entitled Fatty Acids, contains an account of these as they occur in the various essential oils used in soap-making. Chapter III, headed Materials, is devoted to a consideration of the various raw materials employed in the manufacture, the methods of preparing them for use (refining processes), and accounts and cuts of the necessary machinery. Chapter IV deals with the water used in soap manufacture, detailing the undesirable impurities and giving methods for removing them.

The next chapter, on The Manufacture of Soap, gives an account of the essentials of the art as it is practiced to-day. This is followed by a chapter on Packing and Stamping. Chapter VII considers special soaps; Chapter VIII, toilet soaps, and Chapter IX the perfumes commonly used. The next chapter is an account of the methods used for recovering the glycerin set free in the process of saponification. The last chapter consists of a systematic scheme of soap analysis.

The book, although not intended as a popular treatise, contains much that is suited to the untechnical reader, and for one with a little chemical knowledge, who desires to know something of the manufacture of this important article, it is a good text-book. The cuts and detailed descriptions also make it valuable to the manufacturer.

The Pursuit of Happiness. By Daniel G. Brinton, LL. D. Philadelphia: David McKay. Pp. 292. Price, $1.

To seek for happiness and to be happy is not only a legitimate aim in life, but, according to Dr. Brinton, there is no higher object; it alone makes life worth living. The altruist may label this pure selfishness and proclaim that our duty is to live for others; the ascetic may extol self-abnegation as the greatest of virtues; yet if we are to diffuse happiness, we must first be charged with it ourselves—" he wastes his life who devotes his time to anything else than the pursuit of happiness or the search for truth." These quests may be identical, for the first step in learning how to be happy is to get knowledge. Even through "the yearning for joy" evolution has come to us; in groping for pleasurable sensation the amœba has developed into man. The human individual attains happiness when his self-consciousness is brought into harmony with his faculties and surroundings. This involves growth and action. Happiness is not momentary pleasure, it is even compatible with physical pain and mental suffering if these enhance the realization of self. To be happy, one must work and fight as for the promised land. It follows that there is an art of felicity whose laws we may study.

The author considers in detail what are the conditions of happiness; how far it depends on Nature and fate, how far it may be controlled by ourselves and by others, and, finally, what are the consolations of affliction.

On the whole he is a cheerful philosopher, although his view of old age is somber —" a malady that is absolutely fatal," whose pleasures are tolerable. To women he accords justice rather than flattery, for which rare tribute they should be grateful. There is excellent advice to be found in the book, and, unlike many treatises that offer it, this is entertaining and free from pretense or cant of any sort. The range of topics, however, is wide and we meet strange maxims: less than your best will often answer the purpose, and good enough is good. We query whether the author would be satisfied to have these taken as the gauge of his work.

The Diseases of the Stomach. By Prof. C. A. Ewald, M. D. Translated by Morris Manges, M. D. New York: D. Appleton & Co. Pp. 497. Price, $5.

This is a translation of a work that has gone through three editions in Germany, a statement that implies intrinsic merit in a work on a medical subject. This translation has had the further advantage of the author's revision, and thus includes his most recent studies on this subject.

The work is arranged in a series of twelve lectures as they were delivered in the author's course at the University of Berlin; the subjects include the methods of diagnosis and the various diseases of the stomach. The chapter on the neuroses of the stomach is by Prof. R. Ewald.

The author is a clear and logical writer, presenting all the facts that will assist the clinician in making his diagnosis. But he

calls attention to the fact that not even the most careful chemical examination of the functions of the stomach will put within our grasp the divining-rod that will, as it were, "magically call forth the fountain of knowledge from the adamantine rocks of obscure symptoms."

The reputation that the American people have of being a nation of dyspeptics is not altogether without foundation; and where gastric disorders are even moderately prevalent, such a work as this must be of value in enabling all physicians to be well informed regarding the latest methods of diagnosis and treatment of gastric diseases.

The third and concluding volume of Prof. *A. B. Hart's* Epochs of American History—*Division and Reunion*—brings down the narrative from the accession of Jackson to the end of President Cleveland's first administration. In the construction of the series each author has kept his own point of view, and no pains have been taken to harmonize divergencies of judgment; but it is believed that all these substantially agree as to the underlying causes of the growth of our country. The present volume is by *Woodrow Wilson*, and is the work of a master. Only a sketch in broad outline has been attempted—not so much a compact narrative as a synopsis, as rapid as possible, of the larger features of public affairs in the sixty years it covers. The story is told in four parts: the period of critical change, when the spoils system was introduced and sectional divergence began to be disclosed; the period of the prominence of the slavery question; the period of secession and civil war; and the period of the rehabilitation of the Union.

A paper on *The Financial History of Virginia* from 1609 to 1776, published by *William Zebrina Ripley* in the Columbia College Studies in History, Economics, and Public Law, is a contribution to the effort to trace the gradual development of systems and theories in financial management. One does not look, the author says, "to primitive society and its institutions for well-rounded principles and technical details; for to construct a science of finance where there was none in fact, would be to pervert the course of history. Theories do not arise until experience has taught man the abuses attendant upon social life. Consequently the financial history of this oldest American Commonwealth for many years is merely the story of the simple methods adopted by a people too fully occupied in conquering a wilderness to spin fiscal theories, who wanted to support the incipient Government in the easiest possible way." The institution of slavery had a marked influence on the course of development in Virginia, and was the ultimate factor that distinguished this colony from those of New England. The fiscal systems of the two regions became radically different, because the outward conditions of climate, soil, and situation were totally unlike; and the history attests the truth of the law that the direct environment is, after all, the most powerful factor in shaping early social institutions.

The study of *Bankruptcy* in the light of comparative legislation, contributed by *S. Whitney Dunscomb*, Jr., to the Columbia College Series of Studies in History, Economics, and Public Law, comprises a review of the laws and processes of the European nations and the United States relative to insolvency. In the first chapter the conditions are stated which constitute bankruptcy or insolvency under the laws of the several States, and terms are defined. Then the effects are described as to the person and juristic status of the bankrupt, as to his property, and as to the acts performed by him; the operations of bankruptcy; the closing of it, by composition relinquishment of assets, and other methods; the rehabilitation of the bankrupt; and preventive compositions or compositions before bankruptcy. The second part of the essay relates to Bankruptcy in the United States under the National Bankrupt Law and the insolvent laws of the several States.

A book fitting the prominent feature of the immediately present time is *A Brief History of Panics*, "Englished" from the French of *Clement Juglar*, and edited by *De Courcy W. Thom*, who has also furnished an introductory essay setting forth the indications of approaching panic. The book was written before the present disturbances in the money market set in, the premonition of which is spoken of as "a somewhat uneasy feeling about silver," and when some of Mr. Thom's symptoms were already apparent;

yet it conveys the pleasant though now contradicted message that the signs in general justify the prediction "of the steady development of a prosperous period."

In transmitting his *Twentieth Annual Report of the Geological and Natural History Survey of Minnesota*, the State Geologist, *N. H. Winchell*, characterizes the survey, as a State enterprise, as unique in its plan, its supervisory auspices, its slow but uninterrupted progress, and the duration of its personal directorship. Ten years ago, in submitting his tenth annual report, the author ventured to congratulate the university and the State on the success that had accompanied the survey at that date; but the second ten years have been more prosperous than the first ten. The present report contains a paper on the structures and origin of the crystalline rocks, by Mr. Winchell; field observations on certain granite areas, by U. S. Grant; the Mesabic iron range, by N. V. Winchell; the abandoned strands of Lake Superior, by A. C. Lawson; and Diatomaceæ of the Interglacial Drift, by B. W. Thoms and H. L. Smith.

The papers in No. 2 of Volume V of the *Studies in the Biological Laboratory of Johns Hopkins University* are on The Effect of Hæmorrhage and of Fasting on the Proteids of the Blood of Cats, by G. P. Dreyer; The Respiratory Function of some Muscles of the Higher Mammlia, by Theodore Hough; The Latent Time of the Knee-Jerk, by E. C. Applegarth; and The Physiological Effects of Differential Respiration, by Prof. H. Newell Martin and G. P. Dreyer.

A collection of translations of papers on *The Mechanics of the Earth's Atmosphere*, published by *Cleveland Abbe* in the Smithsonian Miscellaneous Collections, includes essays of great technical interest and value by Professors Hagen, Helmholtz, Kirchhoff, Oberbeck, Hertz, and Bezold, Lord Rayleigh, and Professors Margules and Ferrel. Prof. Abbe expresses the opinion that there is a crying need for more profound researches into the mechanics of the atmosphere, and believing that meteorology can be advanced beyond its present stage only by the devotion to it of the highest talent in mathematical and experimental physics, he earnestly commends these memoirs to such students in our universities as are seeking new fields of applied science.

The *Introductory Manual for Sugar Growers* of Mr. *Francis Watts* is the outcome of several years' experience in the West Indies, by which he was shown the necessity for a handbook containing an outline of the principles of agriculture based on modern scientific discoveries, and of the principles underlying the manufacture of sugar. The author hopes that his book may be useful as a starting point for young men beginning their training, and that it may help guide older men to other works. Special attention is given to tropical conditions. (Longmans, Green & Co., $1.50.)

The History of Modern Education, which comprises an account of the course of educational opinion and practice from the revival of learning to the present decade, by Prof. *Samuel G. Williams*, has grown out of the lectures given by the author in Cornell University during the past six years, and comprises the last half of his course on the history of education. It presents a compact, comprehensive, and intelligible summary of the subject. After an introductory chapter on ancient and mediæval education, the history proper begins with the account of the Renaissance, phases of education, educational opinions, and distinguished teachers of the sixteenth century. This is followed by similar notices of characteristics of education in the seventeenth century, the educational reformers and their principles, Female Education and Fénelon, the Oratory of Jesus and Beginning of American Education; then of the eighteenth century, in the general review of which education in New England and New York are characterized, early text-books are described, and the foundation of colleges and of the University of the State of New York is recorded. Among the "educational characteristics of the nineteenth century" are great activity in literature, etc., Herbert Spencer's treatise, the general diffusion of popular education, professional training of teachers, supervision of schools, industrial and manual training, improvements in method, the kindergarten, and the discussion of the relative disciplinary value of studies. (C. W. Bardeen, Syracuse, N. Y. Price, $1.50.)

Practical Lessons in Language is a man-

ual by Benjamin G. Conklin, the lessons in which are intended to cover the last two years of the primary course, and are graded to suit the capacity of pupils as they advance. A picture is given, or a passage to be read; followed by a heading, Things to Notice, under which are included "development questions," which the pupil is to answer in his own language, and the deductions from his answers; and Things to Do—a title which covers varied exercises, all intended to be of a nature to interest the pupil. The aim throughout the book is to lead the pupil to see and think for himself, and when he has mastered it he will have undergone a course of training in observation and original, spontaneous, literary composition. (American Book Company. Price, 35 cents.)

The Presentation of the Life and Educational Works of *John Amos Comenius*, Moravian bishop, the famous educator, by *S. S. Laurie*, is believed by the author to be the most complete and, so far as he knows, the only complete account of Comenius and his works that exists in any language. In preparing it, the author has gone through all of Comenius's didactic writings, and has written the whole from original sources. The volume contains the life and a synopsis of the principal features of the works of Comenius. The publisher, C. W. Bardeen, Syracuse, N. Y., has furnished the present edition with headlines, five portraits, and a bibliography, with photographic reproductions from early editions of the works of the bishop.

The idea of presenting the handbook *Three Roads to a Commission in the United States Army* (D. Appleton & Co.) was suggested to the author, Lieutenant W. P. Burnham, when, shortly after assuming the duties of Professor of Military Science and Tactics at St. John's Military School, Manlius, N. Y., he was surprised to find so much interest manifested in the army, and more so to find how little was known of its real workings. The most remarkable impressions were entertained regarding the character, hardships, and privations of the rank and file of the army. The fact that a commission could easily be obtained from the ranks was not comprehended, many not knowing that such a thing was possible in time of peace. The author has endeavored to throw sufficient light on these points. The character and extent of the examinations for obtaining a commission from the ranks of the army were considerably changed in 1891 and 1892. The rules governing the examinations are taken from the official records of the War Department, which are based on acts of Congress. The three roads to a commission defined and explained in the book are those from the Military Academy, from the army by the appointment of meritorious soldiers, and from civil life—the least frequented of the number.

Science Stories (J. R. Osgood, McIlvaine & Co., London) is a collection of descriptive essays relating principally to the habits and various features of the existence of different animals and plants, originally contributed by the author, *Daniel Wilson*, to the Glasgow (Scotland) Herald. They are reproduced with the view of encouraging "that popular interest in science which is, happily, a feature of our modern life."

The *American Mental Arithmetic* has been prepared by Mr. *M. A. Bailey* for a drill book in which the principles of written arithmetic, except as applied to large numbers, shall be concisely stated and illustrated. Among its features are the placing of principles and illustrations in parallel columns; the beginning of each subject at the top of a page; the systematic placing of explanations and directions under exercises; the prominence of the combination method; the indication of the number of seconds that should be required for the solution of each example; the introduction, in factoring, of the conception of numbers severally prime to each other; the method of presentation of the metric system; the teaching of percentage without rules or formulas; and practical exercises at various places of business. (American Book Company. Price, 35 cents.)

In the *Commercial Arithmetic* of Headmaster *S. Jackson* (Macmillan & Co.) it is assumed that the reader has a competent knowledge of elementary arithmetic, and therefore the theoretical portions of the work are limited to the methods which are best adapted for commercial calculations. An endeavor has been made to give full and accurate information on all commercial subjects of first-rate importance. Certain methods of readily saving labor are suggested. Emphasis is laid on the immense superiority

of decimal operations over all others, and the adoption of the metrical system and a decimal coinage with the sovereign as the basis is favored.

Mr. *Francis Browning Owen*, of Cloquet, Minn., published a volume of poems twenty years ago, and now offers a second and enlarged edition of his writings under the title of *Columbian and other Poems*. His aim has been throughout to write nothing but what would elevate mankind, and to give utterance to "soul-language" rather than to mere words. (Ann Arbor, Mich.: The Register Publishing Co.)

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POPULAR MISCELLANY.

Spencer's Education in English Training Colleges.—For several years Herbert Spencer's book on Education has been a text-book in the schools of England and Wales which correspond to normal schools in America, and has been very highly appreciated. Mr. J. G. Fitch, the widely known educator, who is one of H. B. M.'s chief inspectors on the training colleges for schoolmistresses, says of this work: "In my conferences with the staff of teachers I have occasionally heard that the work of Mr. Spencer was regarded as incomplete and unsatisfying, that it left out of view some important factors in moral training, and that in particular it exalted scientific instruction at the expense of the 'humanities.' But, withal, it is generally

acknowledged to be one of the most stimulating and suggestive treatises on education in the language; and those of the lecturers who have made the book a theme for comment, and occasionally for adverse criticism, speak in the strongest terms of the value of that intellectual discipline which is to be had in discussing both its shortcomings and its many merits." That its alleged imperfections were not deemed very serious even by their discoverers is shown by the fact that, although Locke's Thoughts on Education was permitted as an alternative, Spencer's book was chosen, in 1891, by all but the two Catholic colleges and one other out of twenty-six. Mr. Wilde, one of the inspectors of colleges for schoolmasters, reports that the students "had in all the colleges given to me invariably taken this book." Mr. Byrne, another inspector, speaking of the general influence of the book, says: "Mr. Spencer's little work on education is doing an incalculable amount of good to the elementary teachers of the rising generations. The obligation now imposed on them to study it is bearing fruit by awakening in them an interest in the proper ends and methods of education and instruction which they had never possessed before. That their occupation is an art, and does not consist in obedience to a number of arbitrarily devised rules, is something to have learned."

Pennsylvania Folk Lore.—Dr. D. G. Brinton's account of the folk lore of his early home in Chester County, Pennsylvania, has little that is peculiar, but in most of its traits recalls familiar English customs. The usual superstitions about the moon were in vogue, and there was a mysterious buried treasure of blood money with a legend attached. Some mythical animals were believed in; among them a descendant of the were wolf of the middle ages—a big black dog with fiery eyes, which never appeared except at night, and was an object of terror to those who heard him. He was supposed to haunt a certain valley which people avoided. Another animal of this class was the hoop snake, which was said to form itself into a ring with its tail in its mouth, and to revolve like a wheel, faster than a horse could trot. Dragon flies, as "snake servants," were supposed to warn snakes of approaching danger, and as "snake-feeders," to seek out food and notify the snakes where it could be found. Cats were uncanny; many animals could predict the weather; and "conjuring" was held responsible for many ills, while charms were cherished as competent to remove them. Ghosts were familiar in popular belief, and were in many cases associated with spots connected with scenes of the Revolution. The author was himself somewhat of a ghost-seer in his early days—a faculty which he regrets having lost as he advanced in years. Having such evidence of his own, he was quite prepared to accept without question the statements of others on such points. The later influx of Irish laborers has introduced a mass of folk lore and superstitious notions that did not exist in the region in the author's boyhood. For instance, he never heard that Friday was an unlucky day, or that the number thirteen at dinner was ominous, or that one should stroke himself to avoid the influence of a bad sign.

Animal Life in the Death-Valley Region.—A pointed illustration of the effect of change of environment on the life of a region is given in Dr. A. K. Fisher's report of the birds observed in the course of the examination of the Death-Valley region, California, undertaken by Prof. C. Hart Merriam, under the direction of the Department of Agriculture. While the bird life of any region is affected by various agencies, such as the results of the destruction of forests, the drying of springs and watercourses, etc., in the high Sierra the sheep industry is doing more than any other cause to make that region uninhabitable. During the summer the sheep destroy all the smaller plants and shrubs to such an extent that they do not grow again till the following spring. The author has walked for miles along the hillsides where sheep had recently grazed without seeing any plants except the larger woody shrubs. That this destruction is a potent cause of the scarcity of ground-inhabiting birds is evident by contrast to any one visiting the national parks, where no sheep are allowed to graze, and where vegetation is consequently uninjured and many species of birds abound. Yet two hundred and ninety species and subspecies of birds were found in this region,

and are reported upon. The collection of reptiles and batrachians made by Mr. Leonhard Stejneger is particularly noteworthy as being the first attempt in this country on a similar scale to gather the material of this class according to a national plan and with a definite purpose in view. The result is a fine series of nine hundred specimens, unique in its completeness with respect to geographic localities within the area explored by the expedition, a tract of almost a hundred thousand square miles, comprising a number of nearly parallel desert valleys separated by intervening narrow mountain ranges. The effort to collect every species in all the characteristic localities has resulted in the accumulation of a material by which it has been possible in many instances to follow the geographic variation in its several directions. Thereby the author has been enabled to settle many vexed questions, and to point out various nice distinctions where some of his colleagues had failed, chiefly from lack of suitable material. According to Prof. Merriam's own observations, most of the desert shrubs are social plants and are distributed in well-marked belts or zones, the vertical limits of which are fixed by the temperature during the period of growth and reproduction. The boundaries of the several belts conform largely to the contours of altitude, with such flexures as variations in base level and slope exposure impose.

Conventionalism and Originality.—Having discussed the tendency of conventional and original minds to come into collision on social matters, the London Spectator finds the occasions for collision less in the case of purely intellectual questions, for the conventionals would take so little interest in matters requiring real thought that they would dismiss them unconsidered. But to those capable of appreciating such subjects, how refreshing in their distinctiveness of character are the workings of the original mind, both in ideas and in expression! For there is a touch of genius, or what the French call *feu sacré*, kindling its thoughts. "Life can never be an altogether dull thing in the company of the original man, for his inventive mind will so combine its various elements as to produce a new and unexpected result. He will see things from some point of view disregarded before; like what we have seen, yet somehow quite different—fresh and unexpected as the thoughts of a child. For, in truth, we shall find there is a close kinship between his mind and that of a thoughtful child. Both continually surprise and delight us, because, through ignorance in the one case and disregard in the other, of the ordinary points of view, they simply and naturally take their own. And in both cases there is the probability that they will strike the truth, because, unblinded by convention or prejudice, they aim straight at the heart of a question. We see, both with children and with poor people, that education, however useful as a refiner of the raw material of originality, is no necessity of its existence. For what rare and racy originality do we often find in the sayings of the poor and uneducated! Their conversation may be often richer in this golden ore than that of those who are called their betters; for having heard less of other men's views, their shrewd, observant minds are driven to take their own. . . . Yet, on the other hand, who that delights in certain gifted authors would deny that mental cultivation gives an added grace to originality?"

The Alaskan Climate.—The climate of southeastern Alaska, says Prof. J. J. Stevenson, in the Scottish Geographical Magazine, is a source of constant surprise to visitors from the Atlantic slope. On the same parallels with bleak and dismal Labrador and Cape York on Hudson Bay, where the summer heat penetrates only a few feet below the surface, trees grow three thousand feet above the sea at Wrangel, and up to the mountain tops at Juneau. The rainfall is great, and the variation in temperature is not; the mercury rarely falls below ten degrees above zero at Sitka, and as seldom rises above seventy-five degrees. Of course, the extremes are much greater on the mainland beyond the mountains, where the summer heat and winter cold are much more intense than immediately on the coast. Alaska has not been an unprofitable investment for the United States. The purchase money has been repaid, or nearly so, by royalties on seal-fishing. But the agricultural capabilities are limited indeed. There is little land fitted for tillage; and the moist summer

with its low temperature is unfavorable for the ripening of grain. Gardens, however, are successful at Sitka and Wrangel, and the commoner vegetables are raised without difficulty. Berries of many kinds grow luxuriantly. The remarkable contrast between the Atlantic and Pacific coasts of North America is due to the influence of the Kuro-Siwo, or great Japanese current, which is similar to that of the Gulf Stream on the west coast of Europe. There are many points of resemblance between the two streams. The Japanese current is divided by a cold current, and fogs are produced by the contact, as they are when the Gulf Stream meets the Labrador current in the North Atlantic. The Kamchatka or northerly branch flows into Bering Sea and passes through Bering Strait into the Arctic Ocean, first striking the coast of northern Alaska; the mild climate of that coast is due to it, and possibly its influence on the ocean temperature has much to do with the presence of fur seals in Bering Sea. The main body of the stream crosses the ocean and reaches the American coast not far from the strait of San Juan de Fuca, whence it flows southward to join the great northern equatorial current off Lower California. In spite of the superfluity of rainy and cloudy weather, southeastern Alaska is said to be by no means an uninviting place. In summer the twilight almost meets the dawn, but winter restores the daylight to the general average, for at Sitka lamps are extinguished at nine in the morning, to be relighted at three in the afternoon.

Characteristics of the Tropical Forest.—To the naturalist, says the London Spectator, the most marked feature of the great tropical forest south of the equator is the inequality in the balance of Nature between vegetable and animal life. From the forests of Brazil to the forests of the Congo, through the wooded heights of northern Madagascar, to the tangled jungles of the Asiatic Archipelago and the impenetrable woods of New Guinea, the boundless profusion of vegetable growth is unmatched by any similar abundance in animal forms. A few brilliant birds of strange shape and matchless plumage, such as the toucans of Guinea and the Amazon, or the birds of paradise in the Moluccas or the Papuan Archipelago, haunt the loftiest trees, and from time to time fall victims to the blowpipe or arrow of the natives, who hardly dare to penetrate that foodless region, even for such rich spoils, until incantation and sacrifice have propitiated the offended spirits of the woods; but, except the sloth and the giant ant-eater, there is hardly to be found in the tropical regions of the New World a quadruped which can excite the curiosity of the naturalist or form food even for the wildest of mankind. In the corresponding tracts of Africa and the Asiatic Archipelago the rare four-footed animals that live in the solitary forests are for the most part creatures of the night, and do not leave their hiding places till the tropical darkness has fallen on the forest, when they seek their food, not on the surface of the ground, but, imitating the birds, ascend to the upper surface of the ocean of trees, and at the first approach of dawn seek refuge from the hateful day in the dark recesses of some aged and hollow trunk. There is nothing like the loris or the lemur in the fauna of temperate Europe. We may rather compare them to a race of arboreal moles, the condition of whose life is darkness and invisibility. But, unlike the moles, the smaller members of these rarely seen tribes are among the most beautiful and interesting creatures of the tropics, though the extreme difficulty of capturing creatures whose whole life is spent on the loftiest forest trees is further increased by the reluctance of the natives to enter the deserted and pathless forests. The beautiful lemurs, most of which are found in Madagascar, are further believed by the Malagasi to embody the spirits of their ancestors; and the weird and plaintive cries with which they fill the groves at night, uttered by creatures whose bodies, as they cling to the branches, are invisible, and whose delicate movements are noiseless, may well have left a doubt on the minds of the first discoverers of the island as to whether these were not in truth the cries and wailings of true *lemures*, the unquiet ghosts of the departed.

Indian Basket Colors.—No chemist, says the Lewiston (Maine) Journal, has ever produced brighter colors than are made by the Maine Indian basket makers. For the greater part of the material, ash logs are

taken, though maple is cut for rims and handles. In the salt marshes sweet grass is found, which when dry gives out a fragrant odor. Alder is steeped for pale red, white-birch bark for bright red, cedar boughs for green, and sumac for yellow. Black comes from white-maple bark. A light solution of maple, however, shows purple instead of black. Lazy Indians buy logwood for black, redwood for red, and fustic for yellow. A family of four basket makers in Oldtown cleared one thousand dollars last year, in addition to the household expenses. In the same house where the baskets were made are a four-hundred-dollar piano, a Brussels carpet, lace curtains, plush furniture, a picture of a priest and one of the Virgin Mary, a Catholic epitome, a set of Cooper's novels a stuffed owl, and a peacock, also stuffed. Two canary birds sang in a cage hanging in the room, and on a mat a tired foxhound snored.

Ancient Beginnings of Chemistry.—In a paper presenting evidences of careful study, Prof. H. Carrington Bolton has shown how the beginnings of chemistry were in the very earliest times, when already many arts were practiced involving chemical operations, such as working in metals, purification of natural salts for pharmacy, etc., dyeing of cloths and the preparation of pigments, brewing of fermented liquors, and others. Hence we find that long before chemistry became a science, even before it became inoculated with the virus of alchemy, furnaces and apparatus of earthenware, metal, and glass, adapted to special work, were in common use. The Egyptians attained great skill in industrial arts at a remote period, and have left records of a most enduring character, pictures cut in their granite tombs and temples. There we see the processes of gold washing and smelting; the use of blow-pipes and double bellows for intensifying heat, various forms of furnaces, and crucibles having a shape quite similar to those of to-day. Some of these crucibles preserved in the Berlin Museum date from the fifteenth century B.C. The earliest chemical laboratories of which we have any knowledge are those connected with the Egyptian temples. Each temple had its library and its laboratory, commonly situated in a definite part of the huge structure. In these laboratories the priests prepared the incense, oils, and other substances used in the temple services, and on the granite walls were carved the recipes and processes. These are still to be seen by the archæologist. The Israelites carried with them from Egypt to the promised land knowledge of the technical and artistic skill of their contemporaries, and the Holy Bible contains frequent allusions to industrial arts. Cupellation is plainly described by Jeremiah; metallurgical operations are mentioned in Job, Ezekiel, and other books, and bellows by Jeremiah. Geber, the Arabian physician and chemist of the eighth century, wrote very plainly of chemical processes, describing minutely solution, filtration, crystallization, fusion, sublimation, distillation, cupellation, and various kinds of furnaces and apparatus employed in these operations. He describes in detail the aludel (or sublimatory of glass), the necessary apparatus for filtration, and the water-bath. The last piece (*bain-marie* in French) is said to have been invented by an alchemist named Mary, who is identified with Miriam, the sister of Moses. Perhaps the earliest drawings of strictly chemical apparatus are those in the so-called manuscript of St. Mark, which is a Greek papyrus on the "sacred art" preserved in Venice and recently edited by Berthelot.

Adaptability of the South to Cotton Manufacturing.—The feasibility of establishing profitable cotton manufactures in the Southern States was recently discussed in the Manufacturers' Record of Baltimore by D. A. Tompkins, of the Atherton Mills, Charlotte, N. C., and Henry G. Kittredge, editor of the Boston Journal of Commerce. Mr. Tompkins believes that the conditions at the South are more favorable to the manufacture of cotton than those of any other part of the world—because no freight charges or only trifling ones have to be incurred; the profits of dealers in cotton are eliminated; labor and living are cheaper than in other parts of the United States; the cost of bagging and ties is almost entirely saved, because they can be sold back to the farmers; and the loss of cotton in transportation to other points is saved. Mr. Kittredge does not regard these advantages as

of permanent consequence, or as such as can not be offset by things unfavorable; and he mentions as an opposing condition of great magnitude the enervating effect of the Southern climate. He points to the region within the limits of the Appalachian Mountain system, where the climate partakes to a greater or less degree of the characteristics of that of the Northern States, as the most propitious region for the establishment of the cotton manufacture of the South. The Record expresses the belief that the delightful and salubrious climate of the Piedmont region of the Carolinas lacks nothing needful for successful manufacturing operations.

German Schools.—According to a summary of the German school system by Principal Ernest Richard, of the Hoboken Academy, the people's school (*Volksschule*) comprises a course of eight years in the common branches, with natural history, geography, history, and religion, from which everything that belongs properly to the competency of special schools is carefully kept out. The spirit of these schools, however, changes, according to the relative strength of liberal or reactionary tendencies in the spirit of the times. In many States a compulsory course in the *Fortbildungsschule*, or continuation school, has been introduced, to attend which employers are obliged to give all their employed below a certain age leave of absence. The course in these schools is generally an enlargement of the subjects taught in the people's schools, with a view to the future occupation of the pupils. In the city they try to give instruction most useful for the prospective mechanic, while in agricultural districts the future needs of the farmer are of leading influence in shaping the course of study. Girls are trained in domestic economy and prepared for their future position of wives and mothers. Special trade schools, or industrial or commercial schools, adapted to the special occupations of the place, are also open to the boy who has completed his people's school course. From these elementary schools, with a variety of other schools which one may attend, the pupil passes to the secondary schools—the *Ober-Realschule* the *Realgymnasium*, and the Gymnasium; or the schools of science and modern languages; of these with Latin added; and the humanistic school. These schools are in nine grades, which all have Latin names, from *Prima superior* (the highest) to *Sexta* (the lowest). At the close of the complete secondary course the *Abiturienten Examen* takes place, an examination of maturity for work in the university and the highest technical schools of university rank. The university is considered the soul, the life-giving element of education. Its proper province, even more than preparation for a profession, is, as Prof. Virchow has shown in his rectoral address published in the August Monthly, the search for truth for the sake of truth, the production of new knowledge, the providing of material for the progress of civilization in all its branches. No matter what the political constitution of the State may be, it is free; and the professor's right to teach what in his conviction is the truth is not limited.

Accuracy of American School Books.—The results of an offer recently sent out by the manufacturers of an article of popular use of a prize for the detection of errors in school books are very creditable to the accuracy and thoroughness of American textbooks. The conditions of the offer required that the book be in the English language and actually used in some school, and the error one susceptible of proof, and taught in lectures or lessons, and not merely a typographical mistake, or an error inadvertently made in spelling or grammar; it should not be one that had already been corrected in later editions; it should not be a disputed question of history or opinion; and should be usually recognized by the publisher of the book on submission to him as an error. Two hundred and thirty-five answers were received to the offer, representing one hundred and sixty-eight alleged errors. The greatest number of errors—thirty-eight—were alleged to appear in geographies; next were histories, twenty-one; arithmetics, nineteen; grammars, sixteen; natural history, twelve; readers, ten; chemistries, eight; languages, etymology, civil government, seven each; geometries, four; geologies and miscellaneous criticisms, two each; definitions, zoölogies, books on English, anatomies, astronomies, botanies, drawing-books, trigonometries, and political economies, one each.

Only one misstatement was found in Webster's Dictionary, and only two in Prof. Fiske's Civil Government in the United States. Another offer, on slightly modified terms, has been sent out by the same house, which will doubtless lead to a still more thorough examination of the books. From the present outlook, whatever may be the shortcomings of our school books, they do not lie to any great extent in outright misstatements of fact.

Expenses at Harvard.—The cost of living while at school is a very important item to most college students. Since Prof. Palmer, of Harvard University, showed how it was possible for a student to live there on four hundred and fifty dollars a year, or a little less, many changes have taken place in college life and its surroundings, and aids to economizing have been introduced that did not exist then. In the Foxcroft Club, with its bill of prices ranging from two slices of bread or two cookies for a cent, to ten cents for roast meats, many have been able to board for as little as two dollars a week. The Twenty-one Club has been an active force in lowering the average of student expenses; the Furniture Loan Club, which began in 1890, has been another. The list of rooms in private houses, published at the opening of each college year, has aided, by directing students to the cheapest rentals; and an employment bureau, established in 1887–'88, helps students who may wish to earn their way or a part of it. In order to ascertain the present conditions as to expense, Secretary Frank Bolles recently requested a number of Harvard men to prepare, each in his own way, a statement of his necessary expenditures during the time of his residence at the university, selecting men known to be very poor, earnest, and scholarly, eager to secure remunerative work, and likely to be methodical and accurate in money matters. He publishes, in a pamphlet entitled Students' Expenses, the replies received from forty of them. These replies show that "students of the most intelligent kind are able to meet the expenses of an academic year by a sum appreciably smaller than the four hundred and fifty dollars which was the normal minimum in 1887." As a rule, the letters have a cheerful tone, showing that the student who lives economically "is not necessarily dreary," though he may have less of pleasure and ease than many of his associates. While some of the men have been forced to devote too much time to making money to attain the very highest grade of academic scholarship, few of them have records below the average; and the number of those having conspicuously high records is greater than that of those having poor grades. Several of them have taken active part in athletic supports, and have found time to enjoy themselves in other ways.

The First Climbing of an Alp.—According to Mr. Edwin Swift Balch's interesting paper on Mountain Exploration, the first real Alpine ascent took place in the same year as the landing of Columbus, when Chamberlain Julien de Beaupré, by order of King Charles VIII of France, and with the help of ropes and ladders, climbed Mont Aiguille, "a long narrow wedge, six thousand and eighty feet high, flat at the top, where there are grass and trees." The contemporary account reads that "on June 26, 1492, François de Bosco, almoner to the Seigneur Julien de Beaupré, in company with other hardy adventurers, ascended the Mont Eguille, or Mount Inaccessible, and the day following, having said mass on the said mountain, ate, drank, and reposed thereon. The Seigneur Julien de Beaupré changed the name of the mountain from Eguille, or Montagne Inaccessible, to Eguille Fort, causing it to be baptized in the name of the Holy Trinity by a certain Sébastian de Carect, one of the royal chaplains, and afterward chanting the *Te Deum*, *Salve Regina*, and many other anthems." They saw numerous chamois on the summit, where they spent six days, and found the descent still more horrible than the ascent.

The Zoölogical Garden of Philadelphia.—The Directors of the Zoölogical Society of Philadelphia say in their report for the last year that they have been confined in the administration of the affairs of the society to its legitimate purposes, by the provisions of its charter and their sense of a proper conduct of the trust confided to them. Their constant object has been to place the garden—purely as a zoölogical garden—in the

front rank of such institutions. In this they feel that they have succeeded in a greater measure than is perhaps commonly recognized by the people of the city. The public services rendered by such an institution are comprised in the very definition of education, in its broad modern sense, and need demonstration in this day quite as little as do its other functions in the direction of recreation; yet it is doubtful if the general public perceive as yet the full educational value of an institution that attracts at the same moment, into the same path, two such different elements of human intelligence as the capacity for observation and the love of enjoyment. The last year's season of the garden was less profitable than usual, partly on account of the severity of both the summer and the winter, and partly also, the directors fear, because it has become the victim of that sort of popular apathy to which such institutions are exposed which eschew sensational methods and are not all the time offering novelties. It is to be hoped that the intelligent people of Philadelphia will not permit so worthy an institution to suffer on account of its determination to maintain its high standard.

Ancient Mexican and Hopi Dances.—Certain resemblances, fancied or real, between ceremonials which, according to Spanish historians, were observed by Central American aborigines at the time of the conquest, and those which are at present performed in the least modified of the pueblos of the Southwest, afford a series of interesting facts, which, if they do not point to the kinship of those peoples, may throw light on the study of the comparative ceremoniology of the American race. An example of such resemblance is found by Mr. J. Walter Fewkes in a ceremony described by Padre Sahagun as practiced by the ancient Mexicans, which is comparable in many respects with the Hopi snake dance. In his published study of the subject, Mr. Fewkes gives the Nahuatl text cited by Sahagun, a German translation of it by Dr. Seler, an English translation of that, and a Spanish version with a Mexican plate or tablet illustrating the text. There are many differences between the described ceremony and the Hopi dance, but a striking resemblance appears in the carrying of the snake in the mouths of the participants. The resemblance leads one to look for likeness in symbolism, especially as appertaining to the mythological snake, between the two peoples. A close likeness in this symbolism has not been found among the Nahua people, while with the Mayas there is a remarkable case of similarity or identical symbolism apparently connecting the plumed snake of Yucatan with that of the Hopi towns. From the speculative side there seems probable an intimate resemblance between some of the ceremonials, the symbolism, and the mythological systems of the Indians of Tusayan and those of the more civilized stocks of Central America. In the author's opinion, we are not yet justified in offering any but a theoretical explanation of the origin of the Hopi ceremonial and mythological systems, but their intimate relations with those of the neighboring pueblos indicates a close kinship. The facts recorded in his study look as if the Hopi practice a ceremonial system of worship with strong affinities to the Nahuatl and Mayas. He has not yet seen enough evidence to convince him that the Hopi derived their cult or ceremonials from the Zuñians or from any other single people. It is probably composite.

NOTES.

Polygonum sakhaliæ is the name of a forest plant from the island of Sakhalien, Japan, of which flattering accounts are given by M. Doumet Adanson, who has cultivated a few stools of it in France. He got it as an ornamental plant, and it is really very handsome. It grows to be about six feet high in three weeks; produces a considerable foliage of which cattle are fond; and yields a good second crop after the first cutting. A section of root planted will produce a stool covering a square metre of surface. It takes care of itself.

A league has been formed at Aix-en-Provence, France, for promoting agricultural interests by preserving the small insect-eating birds, and has allied itself with state and local authorities. It will seek to suppress nets and all machinery for capturing birds; to insure the preservation of nests; to forbid the manufacture and sale of spring nets and other bird-catching machinery, and to prohibit the use of poisons and of bird-lime against birds, and in general of anything except the gun for their destruction. It will favor the use of all means for the res-

toration and renaturalization of all useful species that are now tending to disappear. It will also strive to enlist the co-operation of the authorities and administrative officers in all practical measures to save the birds, and so to instruct the public that a generation shall grow up who have not been taught by the example or indifference of their elders that birds are mischievous creatures, to be got rid of, but the contrary.

The second medallist of the Royal Geographical Society this year (M. Selous, the African explorer, being the first) was Mr. Woodland Rockhill, an American diplomatist, who had made himself famous by his explorations in western China and northeastern Thibet.

A writer in the *Génie Civil* has shown that there is a difference in electric potential between the water and gas pipes in all houses, and that if one terminal of a telephone is joined, say, to the water pipe, on lightly touching the gas pipe with the other, a crackling sound will be heard in the telephone, indicating the passage of a current. When the telephone is replaced by the galvanometer, the negative pole is found to be formed by the gas pipe, and the galvanometer deflection to be permanent and constant in amount during several months, but with a slight diurnal variation. The currents are attributed to slow chemical changes. With the currents developed in these pipes the author has succeeded in carrying on a conversation between two houses a hundred metres apart.

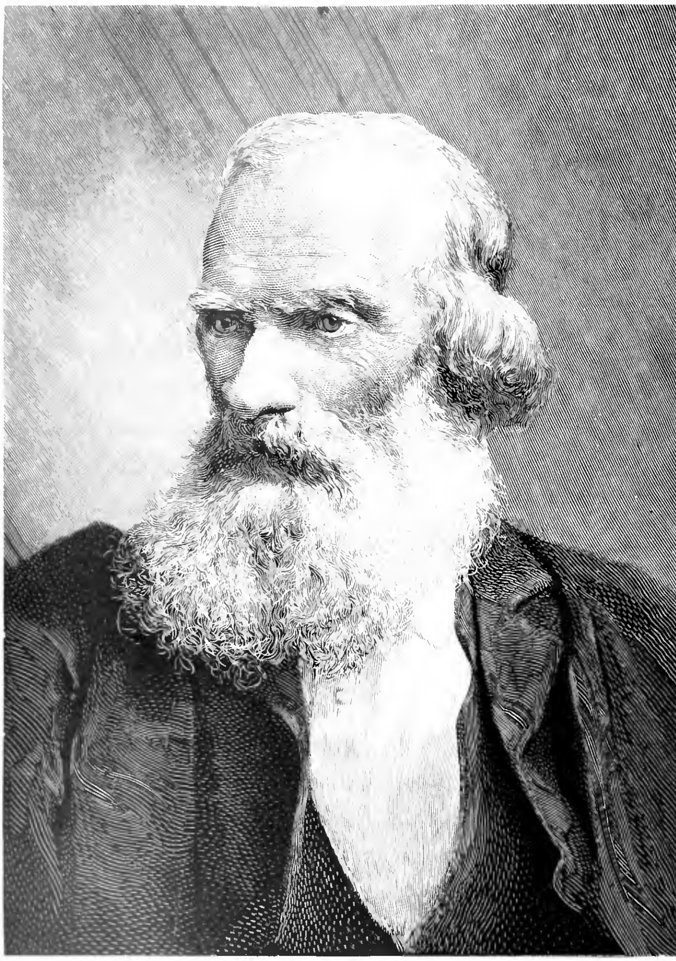
A gorilla which had acquired considerable fame died recently in the Berlin Aquarium. The papers have published accounts of its daily operations. It awoke at eight o'clock in the morning and took a glass of milk. At nine o'clock it made its toilet with as much care as a civilized man, and ate its breakfast a few minutes afterward. This consisted of two Vienna loaves, Hamburg smoked meat, cheese, and white beer. At one o'clock in the afternoon it had a cup of chicken soup with carrot, rice, and potatoes, and an egg. Its evening meal consisted of fruits, bread and butter, and a cup of tea.

The Hindus are curiously frank in specifying their occupations for the census reports. Among the accounts many of them give of their trades they designate themselves as debtors, living on loans, men of secret resources—or plainly thieves, village thieves, or robbers. Others more modestly call themselves guests, visitors, story-tellers from house to house, dependents on relatives, supported by their sons-in-law, or idlers; and one is without work because he is silly. Among the more serious occupations are declarer of oracles, cleaner of eyes, sorcerer, foreteller of storms and hail, player of the tom-tom, or player, barber, doctor according to the Greek method, servant of a candidate, marriage broker of young domestics, marriage broker of his own daughters for money, etc.

According to an address by C. Theodore Williams before the Royal Meteorological Society, the chief features of the climate of Colorado appear to be: 1. Diminished barometric pressure, owing to altitude. 2. Great atmospheric dryness, especially in winter and autumn. 3. Clearness of atmosphere and absence of fog or cloud. 4. Abundant sunshine all the year round, but especially in winter and autumn. 5. Marked diathermancy of atmosphere, producing an increase in the difference between the temperature in the sun and in the shade, varying with the elevation in the proportion of one degree for every rise of two hundred and thirty-five feet. 6. Considerable air movement, even in the middle of summer, which promotes evaporation and tempers the solar heat. 7. The presence of a large amount of atmospheric electricity. Thus the climate is dry and sunny, with bracing and energizing qualities, permitting outdoor exercise all the year round.

According to a paper by Prof. Washington Matthews, of Fort Wingate, New Mexico, read in the American Association, the majority of the very numerous songs of the Navajos are divided into groups and follow in regular sequence; whence they may be called sequence songs. The order of the songs is arranged to correspond with a series of myths, there being a special myth for each set. The set of the "songs in the form of the house god" has thirty songs. In some instances the myth is the more important part of the work; but in more cases it is only a trifling element, and seems devised merely as an aid to the memory, or a means of explaining and giving interest to the songs. The master of ceremonies or leader in the production of these songs, called the *thaman*, must be a man of superior memory and of great intellectual industry. He must commit to memory many hundred songs, some of which are so sacred that the slightest mistake made in repeating them renders void an elaborate and costly ceremonial.

Two reforms in the system of life insurance commended in the English journals are the perfection of a plan by one company the object of which is to lighten the duties of trustees and enable the assurant to make better provision for his wife and children, the details of which are too technical to be published here; and the adoption by another company of a policy affording full and satisfactory information on all subjects concerning its operations and the nature and value of its policies, including those facts by the aid of which the assurant can see for himself what he can get every year upon his policy should he be constrained to sell it or borrow upon it.



DANIEL WILSON.

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THE STORY OF BOB.

By DAVID STARR JORDAN,
PRESIDENT OF LELAND STANFORD JUNIOR UNIVERSITY.

WE called him Bob. We never knew his real name. That had been left in the jungles of Borneo. He was born in 1890, a prince of the tribe of *Cercopithecus* which inhabits the palm forests of the south sea islands. Stolen from his parents by a south sea trader, he was brought to San Francisco, exchanged for a keg of beer, and found his way at last to a Kearny Street curiosity shop.

Not long after, a student of evolution saw him there, ransomed him by a subscription from his fellow-students, and Bob was transferred to a new home in the university beside the Tall Tree. Here he was placed in the custody of a young naturalist from Japan. Otaki being likewise Asiatic by birth, understood the wants and feelings of Bob better than did any of the others by whom he was surrounded.

We first knew Bob as a wild and suspicious creature, who looked at all who came near him with fear or hatred. If any person touched him, Bob would look him straight in the eyes, with scowling face and lips rolled back, every muscle tense for action in case of any injury or indignity. Whenever he was lifted from the ground, all these expressions would be intensified; but he never ventured to bite any one who seemed beyond his size, or to escape from any one he thought able to hold him. Toward women he showed from the first great aversion, for they had poked him in the ribs with their parasols while he was in prison in Kearny Street. Furthermore, he seemed seriously to disapprove the unseemly freedom allowed to women in our country.

In such matters, our manners and customs are very different from those which prevail in the tribe of *Cercopithecus* in Borneo.

After a time, under protest, he let one young woman lead him about by his chain, and refrained from open enmity; but he never gave her either trust or affection. Children he held in utter abhorrence, for it was their delight to ridicule him and to vex his dignity with sticks and clods of earth. When any of them came near him, he would jump at them, hissing and scolding, and often only the strength of his chain saved them from injury.

Bob and the Napa Soda.

When Bob came from Kearny Street his hair was infested with the small, louse-like parasite (*Hæmatopina quadrumanus*) which always abounds where those of his race are gathered together. Bob did not try to conceal this fact; he made it the joy of his leisure. A large part of his time was spent in searching his arms and legs in quest of the insect. When he found or pretended to find one, he would eat it with much appearance of satisfaction, keeping up all the while a vigorous smacking of the lips. A young entomologist became interested in this, and sought to make for himself a collection of these insects from Bob's hair. But while he made his explorations, putting his captures in a small vial, Bob conducted a similar search among the hairs on his friend's hand. The bystanders laughed heartily, but Bob saw nothing funny about the affair. If one could judge by his movements and the smacking of his lips, he was more successful than the naturalist himself. But all this with Bob was simply an excess of politeness. In his tribe of *Cercopithecus* it is the height of courtesy for one individual to go over the head and

shoulders of his friends, taking hold of hair after hair, drawing them through his fingers, so that no parasite can escape. If a stranger in any way earns his good will, Bob will show it by devoting himself to this search either on hand or coat sleeve. At these times Bob is the perfection of courtesy. He pretends to find numberless *Hæmatopinæ* on his friend's hands, even though you can see with your own eyes that he finds nothing at all. And all the time he chuckles and smacks his lips as though each discovery were an object of personal satisfaction to him.

Of snakes, large or small, Bob has always stood in abject terror. If he is held firmly and the snake is placed near him, he looks piteously in the face of his keeper, and sometimes, more in sorrow than in anger, he will bite if he is not let go. At one time a snake in a paper bag was shown him. When the paper bag was afterward left near him, he would furtively approach and open it, to peep a moment shiveringly into its depths, and then retreat ignominiously, only to approach for another peep when he had summoned sufficient courage.

A live salamander was placed on the table by his side. This he looked at with a great deal of interest, finally taking it in his hands, with many precautions. When he saw how inert it was, he laid it down and lost all interest in it.

Toward a flat skin of a coyote and one of a wild cat, used as parlor rugs, Bob showed the same fear as in the presence of the snake. If one brought them near him he would jump wildly about or cower in terror behind a chair. This instinctive fear is apparently an inheritance from the experience of his fathers, whose kingdom was in the land where tigers and snakes were dominant and dangerous. A similar skin without hair and eyes he cared nothing for. At one time he climbed on the back of a chair to get away from the coyote skin. The chair was overturned by his efforts. He saw at once that when the chair fell it would carry him backward to the coyote, so he let go of the chair and, seizing his chain, swung himself off out of the reach of the coyote, while the chair was allowed to go over. This was repeated afterward with the same result.

Bob grew very expert in the use of this chain, which he came at last to regard as a necessary part of his environment. In climbing chairs or trees he always took it into consideration. He never learned to untie knots in it, but would very deftly straighten it whenever it became tangled or kinked. Sometimes he would break fastenings, escaping to the top of the house, clanking his chain as he went. It was not easy to catch him then, for he delighted in freedom. At such times he would manage the chain most skillfully, going back to set it free if it caught on any projection. When very hungry, however, he

would come down to the ground or sit patiently outside the kitchen window, waiting to be coaxed and caught. At one time, after we had been entreating him for an hour, he came down from the house in a rage to scare away some boys who were mocking him from below, and who fled in terror at his approach. When loose in the tall grass, Bob would walk on his hinder limbs, holding his head high, and looking about for birds, in whom he seemed to take much interest. For some reason their calls attracted him. His hands meanwhile were held with drooping wrists like the wrists of persons afflicted with the Grecian bend. Toward most animals and toward persons he could not frighten he usually affected perfect indifference, often not deigning to grant them even a glance.

After Claret—Katzenjammer.

Toward horses and cows, and to other animals "big and unpleasant" to him, he held a great dislike. When Billy, the saddle horse, came near him, Bob would crouch like an angry cat, erecting his hair, humping his back, and scolding vehemently. When in his judgment he was safely out of Billy's reach, he would advance boldly and scold loudly. When he thought Billy too near, he became as small and inconspicuous as possible, to avoid the horse's notice. At one time he was placed on Billy's back, where he went into spasms of fear. When taken into the house, he grew bolder, and, climbing on the back of a chair, he described his adventures volubly and with many gestures to his friend Otaki, who understood it all.

To the big dog Rover he also had strong objections. Rover looked down on Bob with tolerant contempt, as a disagreeable being, not to be shaken like a rat because possibly human. But

when Bob would strike him in the face with the flat of his hand, Rover would snap at him, barking indignantly; but he never caught him, and Bob was careful to keep out of his reach. His discretion could be counted on to get the better of his courage. With the little terrier, Dandy, Bob's relations were often friendly, although there was very little mutual trust. At one time Dandy was deep in the ivy in search of a rat, while Bob had also entered the ivy by another opening for other reasons. They met in the dark in a rat-hole through the ivy leaves, and a sharp conflict ensued, marked by much scolding on the one part and pulling of hair and barking on the other. When Dandy had dragged Bob to the light, both were very much surprised, and they parted with mutual apologies and much shamefacedness.

In Devotions.

Being offered a glass of milk, Bob looked at it for a moment, then took the glass in both hands and drank from it. His mouth being small, much of the milk was spilled on the floor. Being then offered a glass partly full, he handled it more deftly, seeming to understand how to use it. When offered a pewter cup with a handle, he took it in both hands and drank as from the glass, but, noticing the handle, he set the cup down and raised it again properly. Then he drank from it as a child of any other race would have done. He soon learned to drink water from bottles. If the bottle were large, he would use one of his hands to hold it, guiding it to his mouth by his hinder legs. At the first trial he understood the purpose of the cork, which he would draw with his teeth. Then he would look down into the neck of the bottle to see if the water were really there and no deception practiced on him. He also usually shook the bottle before drinking, apparently a custom in

Borneo. Once a bottle of carbonated mineral water ("Napa soda") was given him. He drew the cork, much surprised at the explosion, and the character of the water caused him equal surprise; still he drained the bottle and was apparently pleased with it. A bottle of claret being offered him, he drank eagerly and became much exhilarated, but at the same time much confused. After this he always refused claret, putting the bottle away with a gesture of disapproval. Of water colored by fruit juices he was very fond.

Being left alone in a student's room, he experimented on the bottles there. He drew the cork from bottles of ink and of bay rum; not relishing the contents of either, he poured both into the wash basin.

When he was offered an empty egg shell, he raised it up and looked into the crack from which the contents had been taken. Then he would use his fingers to pull the shell apart, licking the inside of the shell, but apparently disgusted with the small amount of food it contained.

Being shown his reflection in the mirror, he advanced toward it scowling, but soon detecting the sham, he lost all interest in it. A hand glass was given him, but he paid very little attention to his reflection in it, laying it down and turning to other things.

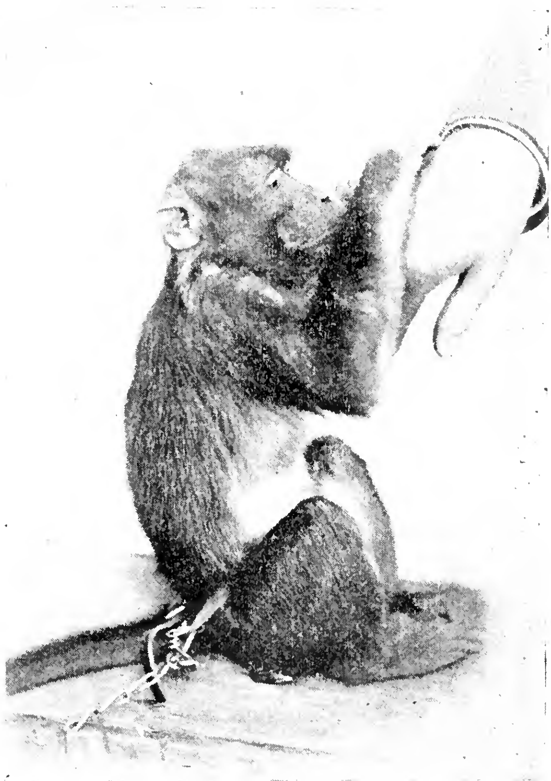
The life of Bob was not without its tender passages. He was loved in turn by the vivacious Mimi and the gentle Nanette. The two stood in much the same relation as the

> ". . . ladies twain
> Who loved so well the tough old dean."

In Borneo, among the tribes of *Cercopithecus*, the male is easily the lord of creation. The female expects to be crowded aside and frequently punished, and takes rude treatment as a matter of course. A kind expression now and then, an occasional hour devoted to hunting *Hæmatopinæ* in her hair, or even a cessation of blows and bites, and she is thankful and satisfied.

Mimi was of the tribe of *Macacus*, gentle in manner, excessively quick of foot, impatient of restraint or even touch from any hand except that of her chosen lord and master. She had large, projecting gray eyes—"pop-eyes" her rivals might have called them—and a wrinkled face suggestive of an age she did not possess. Her face readily assumed an expression of most impatient contempt if any one not of her race attempted to caress her or to take any liberty with her. Mimi had been brought as a child from the south sea islands, and had grown up in a Mayfield beer hall, where she had learned to drink beer with the rest of them, and in general "knew the world," as most of us who live outside the jungles of Borneo are compelled to know it.

Mimi pleased Bob from the first, though he was careful never to let her forget her proper station. If, for example, she had any food he wanted, or if others showed her special attention, he would seize her chain, draw her up to him, and bite her forcibly in the neck, which is the time-honored sign of domestic supremacy in Borneo. At this she would squeal lustily, but she never offered resistance or showed any kind of resentment. Masculine supremacy is acknowledged in the tribe of *Macacus* as in that of *Cercopithecus.* Often Bob would draw Mimi to him to bite her in the neck, apparently to remind her of his superiority. At night they slept together in one box, each with a soft arm round the other's waist.



"CHUMMY."

Nanette, who came later, was also of the tribe of *Macacus,* but she was of a different branch of the great family. She was much larger than Mimi, nearly as large as Bob himself. She had lived in a French family, where she had acquired her name and her calm, considerate manner. She was a gentle blonde, with a pensive, averted face, as though the present was merely an object of toleration with her. Evidently Nanette had had a history, but what that history was no one now can tell. Perhaps there was no history, and her sadly patient expression came from the absence of one.

Mimi was soon very jealous of Nanette, but without good reason, for Bob treated Nanette with uniform contempt, pushing her about and biting her in the neck whenever she came near him. In this Mimi would assist, often seizing Nanette's chain and pulling her about till she was brought within Bob's reach. After a time Mimi's former master returned; she went back to her

drinking of beer, grimacing at visitors, and Bob and this history see her no more.

Meanwhile Nanette and Bob were left together. He remained contemptuous toward her, robbing her of her food and treating her with indignity. Often, when others were looking, Bob would show his authority over her by ostentatiously drawing up her chain and nipping her in the neck; but at other times, when no one was watching, he would relax his dignity and the two would lie for hours in the sunshine, each picking fleas from the other's hair. However, roughly as she was treated, Nanette never showed resentment, and seemed only too glad to be the slave of her royal Bob.

Aspirations.

At one time Bob had treated Nanette with peculiar severity, for which reason Lady Jane gave him a good beating. Nanette, the gentle, took his part, turned on the lady, and would have severely bitten her had she not been taken off. For two months after, whenever the Lady Jane approached Nanette, she would fly into a passion, scolding, trying to bite, and showing every sign of hate possible to the race of *Macacus*. But Bob had only contempt for feminine wrath and its manifestations. Whenever Nanette made any demonstration against the lady, Bob would seize her and bite her in the neck until she cried for pain. But all this time she would not look at him, but kept her wrathful eyes fixed on the lady, willing to suffer anything rather than have Bob's feelings hurt.

Nanette would often leap into the lap of her keeper, seeking the caresses she did not always secure from Bob. This she would do with the manners of a lapdog or a pampered cat. But Bob

never sought caresses. He was always serious, never in the least playful or sentimental. Any new proposition he always takes seriously. He expects the worst, and scowls and shows his teeth until the matter is thoroughly understood, when he usually becomes indifferent.

One day the children vexed him overmuch, and breaking his chain he came out among them. They fled in consternation, all but the younger one, who was a brave little knight and who stood his ground, though at the cost of a serious biting.

And thus it came that after two years of freedom Bob has returned to the curiosity shop in Kearny Street—not the one on the right as you go up Pine Street, but the other one, where the red-tailed parrots scold and swear, and among whose oaths you may hear all the varied languages of the south sea islands. And there in a little iron cage he remains cramped and unhappy. All day long he rolls back his sneering lips, shakes the cage by pulling against the bars, and swings himself to and fro, trying to overturn the cage and cast it on the floor. And here he waits till his ransom is paid again. Fifteen dollars, I believe, is the sum at which it is fixed. Whoever does this will open for him the door to another series of adventures.

HOW OLD IS THE EARTH?

By Prof. WARREN UPHAM.

WITHIN the memory of men now living, and especially during the last thirty years, the processes of the creation of the earth and its inhabitants, of the solar system, and of the starry heavens, have come to be understood in a very different way from that in which they were thought of by our fathers and forefathers. Instead of the former belief that divine fiats at successive times suddenly spoke into existence the forms of animal and plant life now occupying the earth, the earlier faunas and floras found fossil in the rocks, and at still earlier dates the earth itself, the sun, and the entire astronomic universe, it is now recognized and confidently accepted on all sides that all animals and plants, the globe which we inhabit, and the sun and stars, have been created through slow processes of development, which are well denominated evolution—that is, an unrolling or unfolding. These changes have been in progress during unnumbered and inconceivably long ages; they are still going forward; and they will probably continue as far into the unfathomable future as they have come to us through the dimly and in part somewhat clearly discerned past. To us who are borne upon its bosom this current

seems like the lower Amazon, too broad for us to see its banks, coming from the high Andes and the lower plains, and going to its rest in the ocean.

According to the well-approved nebular hypothesis of Kant and Laplace, the material of our earth and moon became separated from the condensing mass of the sun after the outer planets had been similarly produced, but before the birth of Venus and Mercury. At early stages in the condensation of the revolving nebula, it had thrown off successively the portions of matter which were afterward gathered, by their independent condensation and revolution, to form Neptune, Uranus, Saturn, Jupiter, and Mars; while another portion, which was probably never united like the other planets, made the many small asteroids. The matter which has been changed into our splendidly luminous sun was at one time very attenuated and occupied the whole space inclosed by the orbit of the outermost planet, which was developed from a comparatively very small cloud or ring of this matter, centrifugally detached from the revolving exceedingly tenuous mass. In like manner the material of each of the planets, including the earth, was shed from the whirling nebula at times during its decrease in volume when its circumference was approximately coincident with their orbits.

Again, in their turn the planetary masses have undergone the same evolutionary process, taking a rotary motion and throwing off, as they condensed, the material which now circles about them in the shape of moons and rings. In the case of our own planet and its single large satellite, probably the far greater part of the original cloud or ring whence they were produced had assumed a somewhat globular or discoid form and taken a movement of revolution which still continues as the earth's daily rotation, before the moon's mass was separated from that of the earth. It seems to me, however, very improbable that the present contour of our globe should preserve, as suggested by Fisher, the scars of this loss in the depressions of the deep ocean basins.

Many relatively small portions of the ring of matter producing the earth and moon may have become early separated from the chief condensing mass, and after its division in our globe and its satellite have been drawn by gravitation into them, marring the face of the moon, as Gilbert supposes, with its multitudes of both small and very large crateriform scars. On the earth, too, if this hypothesis be true, such falling asteroid-like bodies must also have made similar small and huge blots by their violent impact; but they evidently were effaced by the slow processes of atmospheric and stream erosion, or in basin areas were deeply covered by sediments, before the formation of the oldest of our

fossiliferous strata. The absence of either air or water on the moon has allowed the steep and jagged mountain rims of the deeply depressed lunar craters to remain nearly unchanged from the almost inconceivably remote time, according to this view, when the asteroid bombardment of the moon was completed.

Geology, or the science of the earth's changes and development, deals with the rocks forming the crust of our globe. From their stratigraphic sequence and the successive fossil faunas and floras found in them, the geologist gathers the history of the sedimentation or volcanic eruption of the rocks and the concurrent changes of animal and plant life. Moreover, by reasoning from the physical condition and structure of the rock formations, from volcanic action, earthquakes, and the upheaval of continents and mountain ranges, he conjectures what may be the condition of the deep interior of the earth, through its observed influence upon the crust. Both these phases of the science have yielded estimates of the age of the earth, the former based on the geologic processes of erosion and deposition, the latter on the earth's loss of internal heat, the magnitude and the effects of the oceanic tides, and other conditions whose investigation belongs more specially to the physicist and astronomer. Each takes up the question for the later part of the earth's planetary existence, after it was so far condensed and cooled that it had already attained approximately its present size and was enveloped by a crust which, through many stages of diverse changes, has continued to the present day.

The estimates derived from these two directions of inquiry, however, differ considerably among themselves, and especially it is noticeable that in general the physical and astronomical investigations of the question yield smaller estimates than those drawn from stratigraphic and paleontologic data. Sir William Thomson (now Lord Kelvin) long ago estimated, from his study of the earth's internal heat, its increase from the surface downward, and the rate of its loss by radiation into space, that the time since the consolidation of the surface of the globe has been somewhere between twenty million and four hundred million years, and that most probably this time and all the geologic record must be limited within one hundred million years. Mr. Clarence King, from very careful experiments on the volcanic rock diabase, supposed to represent the average constitution of the earth's crust, when subjected to extremes of heat and pressure, applying his results in the same way as Lord Kelvin, has within the present year published his conclusion that the earth's duration measures only about twenty-four million years. Prof. George H. Darwin computes, from the influence of tidal friction in retarding the earth's rotation, that probably only fifty-seven million years have elapsed since the moon's mass was shed from the revolving molten

earth, long before the formation of its crust. From the same arguments and the rate at which the sun is losing its store of heat, Prof. Guthrie Tait affirms that apparently ten million years are as much as physical science can allow to the geologist. Prof. Newcomb writes: "If the sun had, in the beginning, filled all space, the amount of heat generated by his contraction to his present volume would have been sufficient to last eighteen million years at his present rate of radiation. . . . Ten million years . . . is, therefore, near the extreme limit of time that we can suppose water to have existed on the earth in the fluid state." Not only the earth but even the whole solar system, according to Newcomb, "must have had a beginning within a certain number of years which we can not yet calculate with certainty, but which can not much exceed twenty million, and it must end."

The geologist demurs against these latter far too meager allotments of time for the wonderful, diversified, and surely vastly long history which he has patiently made out in his perusal of the volume of science disclosed by the rocks. He can apparently do very well with Lord Kelvin's original estimate, but must respectfully dissent from the less liberal opinions noted. Somewhere in the assumed premises which yield to mathematicians these narrow limits of time, there must be conditions which do not accord with the actual constitution of the sun and earth. It must be gratefully acknowledged, however, in the camp of the geologists, that we owe to these researches a beneficial check against the notion once prevalent that geologic time extends back practically without limit; and it is most becoming for us carefully to inquire how closely the apparently conflicting testimonies of geology and physics may be brought into harmony by revision of each.

Among all the means afforded by geology for direct estimates of the earth's duration, doubtless the most reliable is through comparing the present measured rate of denudation of continental areas with the aggregate of the greatest determined thickness of the strata referable to the successive time divisions. The factors of this method of estimate, however, are in considerable part uncertain, or dependent on the varying opinions of different geologists. According to Sir Archibald Geikie, in his presidential address a year ago before the British Association, the time thus required for the formation of all the stratified rocks of the earth's crust may range from a minimum of seventy-three million up to a maximum of six hundred and eighty million years. Prof. Samuel Haughton obtains in this way, "for the whole duration of geological time a minimum of two hundred million years." On the other hand, smaller results are reached through the same method by Dana, who conjectures that the earth's age may be

about forty-eight million years since the formation of the oldest fossiliferous rocks; and by Alfred Russel Wallace, who concludes that this time has probably been only about twenty-eight million years. With these, rather than with the foregoing, we may also place Mr. T. Mellard Reade's recent estimate of ninety-five million years, similarly derived. Again, Mr. C. D. Walcott, in his vice-presidential address before Section E of the American Association for the Advancement of Science, in its meeting last August, gave his opinion, from a study of the sedimentary rocks of the western Cordilleran area of the United States, that the duration of time since the Archæan era has been probably some forty-five million years.

Selecting the lowest of these various estimates as the nearest in accord with the conclusions of physical and astronomical science, let us scrutinize the processes of Wallace's measurements and computations. It has been found that the rates at which rivers are lowering the altitudes of their basins by the transportation of sediments to the sea vary from an average of one foot taken from the land surface of its hydrographic basin by the river Po in seven hundred and thirty years, to one foot by the Danube in six thousand eight hundred years. As a mean for all the rivers of the world, Wallace assumes that the erosion from all the land surface is one foot in three thousand years. The sediments are laid down in the sea on an average within thirty miles from the coast, and all the coast lines of the earth have a total measured length, according to Dr. James Croll and Mr. Wallace, of about one hundred thousand miles, so that the deposition is almost wholly confined to an area of about three million square miles. This area is one nineteenth as large as the earth's total land area; hence it will receive sediment nineteen times as fast as the land is denuded, or at the rate of about nineteen feet of stratified beds in three thousand years, which would give one foot in one hundred and fifty-eight years. With this Wallace compares the total maxima of all the sedimentary rocks of the series of geologic epochs, measured in whatever part of the earth they are found to have their greatest development. Prof. Haughton estimates their aggregate to be one hundred and seventy-seven thousand two hundred feet, which, multiplied by one hundred and fifty-eight, gives approximately twenty-eight million years as the time required for the deposition of the rock strata in the various districts where they are thickest and have most fully escaped erosion and redeposition.

Most readers, following this argument, would infer that it must give too large rather than too scanty an estimate of geologic duration; but to many students of the earth's stratigraphy it seems more probably deficient than excessive. All must confess

that the argument rests upon many indeterminate premises, since the total extent of the land areas and the depths of the oceans have probably been increasing through the geologic eras, and the effects of tides have probably diminished. The imperfection of the geologic record, so impressively shown by Charles Darwin in respect to the sequence of plants and animals found fossil in the rocks, will also be appealed to as opposing the assumption that the one hundred and seventy-seven thousand two hundred feet, or thirty-three and a half miles, of strata represent the whole, or indeed any more than a small fraction, of the earth's history. To myself, however, this last objection seems unfounded, since in many extensive and clearly conformable sections observed on a grand scale in crossing broad areas, there is seen to have been evidently continuous deposition during several or many successive geologic epochs; and by combining such sections from different regions a record of sedimentation is made well-nigh complete from the earliest Palæozoic morning of life to its present high noon. But perhaps we may do better to change somewhat the premises of our computation, in view of the extensive regions where the rock strata remain yet to be thoroughly explored, and because of certain large inland tracts having little rain and therefore no drainage into the sea. If we assume that the total maxima of strata amount to fifty miles, and that the mean rate of the land denudation is only one foot in six thousand years, we then obtain a result three times greater than before, or about eighty-four million years for the deposition of the stratified rocks.

Another method of considering this problem is afforded by the determination of one term in a sequence of ratios, whereby the sum of the whole becomes known. Though geologists differ widely in their estimates of the earth's age, up to the seven thousand million years claimed by McGee, in an address last year before the American Association, they are approximately in agreement as to the ratios of the several great divisions of geologic time. From the thicknesses of the strata and the changes in the animal and plant life, it is comparatively easy to determine the relative lengths of the successive eras, while yet it is very difficult to decide beyond doubt even the approximate length in years of any part of the record. The portions for which we have the best means of determining their lengths are the Glacial and recent periods, the latter extending from the Champlain epoch, or closing stage of the ice age to the present time, while these two divisions, the Glacial or Pleistocene period and the recent, make up the Quaternary era. If we can only ascertain somewhat nearly what has been the duration of this era, from the oncoming of the Ice age until now, it will serve as a known quantity to be used as the multiplier for giving us the approximate or probable meas-

ures in years for the recedingly earlier and far longer Tertiary, Mesozoic or Secondary, Palæozoic or Primary, and Archæan or Beginning eras, which last takes us back almost or quite to the time when the cooling molten earth became first enveloped with a solid crust.

Haughton has estimated time ratios from two series of data. His results deduced from the maximum thickness of the strata for the three grand divisions of Archæan, Palæozoic, and subsequent time, expressed in percentages, are 34·3 : 42·5 : 23·2; and from his computations as to the secular cooling of the earth, 33·0 : 41·0 : 26·0. The ratios reached by Profs. J. D. Dana and Alexander Winchell from the thicknesses of the rock strata are closely harmonious, the durations of Palæozoic, Mesozoic, and Cenozoic time being to each other as 12 : 3 : 1. The Tertiary and Quaternary ages, the latter extending to the present day, which are here united as the Cenozoic era, Dana would rank approximately in the ratio of 3 : 1, giving to the Quaternary a sixty-fourth part of all time since the beginning of the Cambrian period, to which our earliest well-preserved fossil faunas belong. For reasons to be stated later, I think that this estimate of the relative length of Quaternary time is greatly exaggerated; but this would not sensibly affect the general ratios.

Prof. W. M. Davis, of Harvard University, without speaking definitely of the lapse of time by years, has endeavored to give some conception of what these and like estimates of geologic ratios really mean, through a translation of them into terms of a linear scale. Starting with the representation of the postglacial or recent period, since the North American ice-sheet was melted away, as two inches, he estimates that the beginning of the Tertiary erosion of the Hudson River gorge through the Highlands would be expressed by a distance of ten feet; that the Triassic reptilian tracks in the sandstone of the Connecticut Valley would be probably fifty feet distant; that the formation of the coal beds of Pennsylvania would be eighty or one hundred feet back from the present time; and that the Middle Cambrian trilobites of Braintree, Mass., would be two hundred, three hundred, or four hundred feet from us.

Having such somewhat definite and agreeing ratios, derived from various data by different investigators, can we secure the factor by which they should be multiplied to yield the approximate duration of geologic epochs, periods, and eras, in years? If on the scale used by Prof. Davis we could substitute a certain time for the period since the departure of the ice-sheet, we should thereby at once determine, albeit with some vagueness and acknowledged latitude for probable error, how much time has passed since the Triassic tracks were made, the coal deposited, and the

trilobites entombed in the Cambrian slates. Now, just this latest and present division of the geologic record, following the Ice age, is the only one for which geologists find sufficient data to permit direct measurements or estimates of its duration. "The glacial invasion from which New England and other northern countries have lately escaped," remarks Davis, "was prehistoric, and yet it should not be regarded as ancient."

In various localities we are able to measure the present rate of erosion of gorges below waterfalls, and the length of the postglacial gorge divided by the rate of recession of the falls gives approximately the time since the Ice age. Such measurements of the gorge and Falls of St. Anthony by Prof. N. H. Winchell show the length of the postglacial or recent period to have been about eight thousand years; and from the surveys of Niagara Falls Mr. G. K. Gilbert believes it to have been seven thousand years, more or less. From the rates of wave-cutting along the sides of Lake Michigan and the consequent accumulation of sand around the south end of the lake, Dr. E. Andrews estimates that the land there became uncovered from its ice-sheet not more than seventy-five hundred years ago. Prof. G. Frederick Wright obtains a similar result from the rate of filling of kettle-holes among the gravel knolls and ridges called kames and eskers, and likewise from the erosion of valleys by streams tributary to Lake Erie; and Prof. Benjamin K. Emerson, from the rate of deposition of modified drift in the Connecticut Valley at Northampton, Mass., thinks that the time since the Glacial period can not exceed ten thousand years. An equally small estimate is also indicated by the studies of Gilbert and Russell for the time since the last great rise of the Quaternary lakes Bonneville and Lahontan, lying in Utah and Nevada, within the arid Great Basin of interior drainage, which are believed to have been contemporaneous with the great extension of ice-sheets upon the northern part of our continent.

Prof. James Geikie maintains that the use of palæolithic implements had ceased, and that early man in Europe made neolithic (polished) implements, before the recession of the ice-sheet from Scotland, Denmark, and the Scandinavian peninsula; and Prestwich suggests that the dawn of civilization in Egypt, China, and India may have been coeval with the glaciation of northwestern Europe. In Wales and Yorkshire the amount of denudation of limestone rocks on which bowlders lie has been regarded by Mr. D. Mackintosh as proof that a period of not more than six thousand years has elapsed since the bowlders were left in their positions. The vertical extent of this denudation, averaging about six inches, is nearly the same with that observed in the southwest part of the province of Quebec by Sir William Logan and Dr.

Robert Bell, where veins of quartz marked with glacial striæ stand out to various heights not exceeding one foot above the weathered surface of the inclosing limestone.

From this wide range of concurrent but independent testimonies we may accept it as practically demonstrated that the ice-sheets disappeared from North America and Europe some six to ten thousand years ago. But having thus found the value of one term in our ratios of geologic time divisions, we may know them all approximately by its substitution. The two inches assumed to represent the postglacial portion of the Quaternary era may be called eight thousand years; then, according to the proportional estimates by Davis, the Triassic period was probably two million four hundred thousand years ago; the time since the Carboniferous period, in the closing part of the Palæozoic era, has been about four or five million years; and since the middle of the Cambrian period, twice or perhaps four times as long. Continuing this series still further back, the earliest Cambrian fossils may be twenty or twenty-five million years old, and the beginning of life on our earth was not improbably twice as long ago.

Seeking to substitute our measure of postglacial time in Dana's ratios, we are met by the difficulty of ascertaining first its proportion to the preceding Glacial period, and then the ratio which these two together bear to the Tertiary era. It would fill a very large volume to rehearse all the diverse opinions current among glacialists concerning the history of the Ice age, its wonderful climatic vicissitudes, and the upward and downward movements of the lands which are covered with the glacial drift. Many eminent glacialists, as James Geikie, Wahnschaffe, Penck, De Geer, Chamberlin, Salisbury, Shaler, McGee, and others, believe that the Ice age was complex, having two, three, or more epochs of glaciation, divided by long interglacial epochs of mild and temperate climate when the ice-sheets were entirely or mainly melted away. Prof. Geikie claims five distinct glacial epochs, as indicated by fossiliferous beds lying between deposits of till or unstratified glacial drift, and by other evidences of great climatic changes. In this country Mr. McGee recognizes at least three glacial epochs. The astronomic theory of Croll attributes the accumulation of ice-sheets to recurrent cycles which bring the winters of each polar hemisphere of the earth alternately into aphelion and perihelion each twenty-one thousand years during the periods of maximum eccentricity of the earth's orbit. Its last period of this kind was from about two hundred and forty thousand to eighty thousand years ago, allowing room for seven or eight such cycles and alternations of glacial and interglacial conditions. The supposed evidence of interglacial epochs therefore gave to this theory a wide credence; but the recent determina-

tions of the geologic brevity of the time since the ice-sheets disappeared from North America and Europe make it clear, in the opinions even of some of the geologists who believe in a duality or plurality of Quaternary Glacial epochs, that not astronomic but geographic causes produced the Ice age.

Glacialists who reject Croll's ingenious and brilliant theory mostly appeal to great preglacial altitude of the land as the chief cause of the ice accumulation, citing as proof of such altitude the fiords and submarine valleys which on the shores of Scandinavia, and the Atlantic, Arctic, and Pacific coasts of North America, descend from one thousand to three thousand and even four thousand feet below the sea level, testifying of former uplifts of these continental areas so much above their present heights. But beneath the enormous weights of their ice-sheets these lands sank, so that when the ice attained its maximum area and thickness and during its departure the areas on which it lay were depressed somewhat lower than now and have since been re-elevated. This view to account for the observed records of the Glacial period is held by Dana, Le Conte, Wright, Jamieson, and others, including the present writer. It is believed to be consistent either with the doctrine of two or more glacial epochs during the Quaternary era, or with the reference of all the glacial drift to a single glacial epoch, which is thought by Wright, Prestwich, Lamplugh, Falsan, Holst, Nikitin, and others to be more probable. To myself, though formerly accepting two glacial epochs with a long warm interval between them, the essential continuity of the Ice age seems now the better provisional hypothesis, to be held with candor for weighing evidence on either side.

The duration of the Ice age, if there was only one epoch of glaciation, with moderate temporary retreats and readvances of the ice border sufficient to allow stratified beds with the remains of animals and plants to be intercalated between accumulations of till, may only have comprised a few tens of thousands of years. On this point Prof. Prestwich has well written as follows: "For the reasons before given, I think it possible that the Glacial epoch —that is to say, the epoch of extreme cold—may not have lasted longer than from fifteen thousand to twenty-five thousand years, and I would for the same reasons limit the time of . . . the melting away of the ice-sheet to from eight thousand to ten thousand years or less."

From these and foregoing estimates, which seem to me acceptable, we have the probable length of Glacial and postglacial time together thirty thousand or forty thousand years, more or less; but an equal or considerably longer preceding time, while the areas that became covered by ice were being uplifted to great altitudes, may perhaps with good reason be also included in the Quaternary

era, which then would comprise some one hundred thousand years. Comparing the Tertiary era with the Quaternary, however, I can not agree with Prof. Dana's estimate that the latter was a third as long as the former, and am quite at a loss to discern evidences justifying that view. The best means for learning their ratio I think to be found in the changes of faunas and floras since the beginning of the Tertiary era, using especially the marine molluscan faunas as most valuable for this comparison. Scarcely any species of marine mollusks have become extinct or undergone important changes during the Glacial and recent periods; but since the Eocene dawn of the Tertiary nearly all of these species have come into existence. Judged upon this basis, the Tertiary era seems probably fifty or a hundred times longer than the Ice age and subsequent time; in other words, it may well have lasted two million or even four million years. Taking the mean of these numbers, or three million years, for Cenozoic time, or the Quaternary and Tertiary ages together, we have precisely the value of Prof. Dana's ratios which he himself assumes for conjectural illustration, namely, forty-eight million years since the Cambrian period began. But the diversified types of animal life in the earliest Cambrian faunas surely imply a long antecedent time for their development, on the assumption that the Creator worked before then as during the subsequent ages in the evolution of all living creatures. According to these ratios, therefore, the time needed for the deposition of the earth's stratified rocks and the unfolding of its plant and animal life must be about a hundred million years.

Reviewing the several results independently reached through the geologic estimates and ratios supplied by Wallace, Dana, and Davis, we are much impressed and convinced of their approximate truth by their somewhat good agreement among themselves, which seems as close as the nature of the problem would lead us to expect, and by their all coming within the limit of one hundred million years which Sir William Thomson estimated on physical grounds. This limit of probable geologic duration seems therefore fully worthy to take the place of the once almost unlimited assumptions of geologists and writers on the evolution of life, that the time at their disposal has been practically infinite. No other more important conclusion in the natural sciences, directly and indirectly modifying our conceptions in a thousand ways, has been reached during this century.

MODERN WAR VESSELS OF THE UNITED STATES NAVY.

By W. A. DOBSON, M. S. N. A.

Illustrated by CHARLES C. DODGE.

AT the close of the civil war the United States possessed a navy consisting in the main of monitors, double and single turreted, and a large fleet of wooden vessels of various types and classes; they were armed principally with smooth-bore guns and Parrott rifles, all of which were muzzle-loading; but the four years of strife which developed the monitor, the fifteen-inch gun with its mammoth powder, and the destructive capabilities of the torpedo were destined to overthrow Old World ideas of battle-ship requirements, to turn the thoughts of naval men abroad in entirely new and novel directions, and to inaugurate a new system of design and construction. Among the forms of naval architecture developed by the exigencies of the war the most notable is the monitor type, and therein contained was the germ from which was to spring a new development of war vessels, for, although the nation was so worn with the long struggle that it was glad to turn the energies that had been devoted to the enterprises of war to the pursuits of peace, and found itself too heavily burdened with debt to embody its naval experience in a new navy, the lessons given in naval construction and warfare were eagerly seized upon by European naval architects, and from the monitor of Ericsson, combined with Timby's revolving fort and its successors, was evolved the battle-ship of to-day. The United States having thus laid down the broad lines along which was to be developed the present fighting machine, with its steel built-up rifled guns, the slow-burning smokeless powder, the automobile and dirigible torpedoes, contented itself for the next decade and a half with building a few vessels of iron, building and repairing its wooden vessels, and converting the smooth-bore guns into makeshift rifles. Abroad, the navies of France and England adopted the monitor idea of protection to hull and machinery by means of vertical side armor, extending from a few feet below to a few feet above the load line, surmounted by a flat armored deck, with the guns placed in revolving forts or turrets, protected by walls of heavy armor; and in order to increase the habitability and sea-going qualities, light upper or false works were erected upon the armor deck, in which were placed the quarters and secondary armament. In order to obtain a hull structure sufficiently light and strong to allow a considerable amount of displacement to be devoted

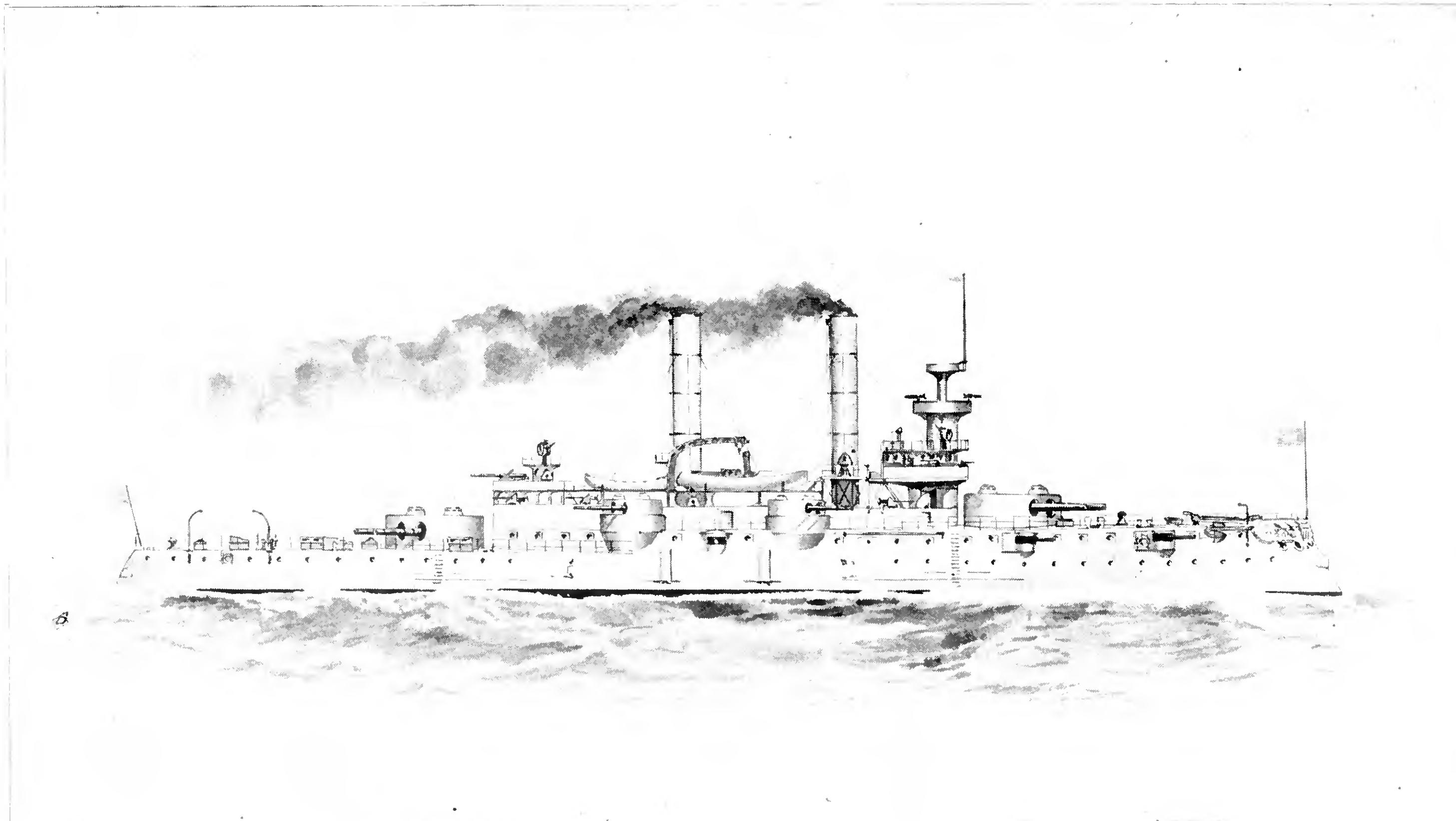


FIG. 1.—UNITED STATES STEAMER IOWA. Battle-ship.

to purposes of protection, a style of construction now universally adopted and known as cellular was developed by Sir E. J. Reed, then chief constructor of the British Navy, in which the maximum of strength with the minimum of weight was sought after and very fairly obtained. Then began, what has continued to this day, the race between armor and armament; the makers of armor striving to make plates that would effectually resist the largest guns, and the gun-makers using every means at their command to produce guns capable of breaking up or penetrating the heaviest armor. The outcome is, on the side of armor, the solid steel plate with a face case-hardened by the Harvey process—a face so hard that no drill will in the slightest degree affect it, and this extreme hardness gradually shaded off to a soft back to prevent through cracks. On the other hand is the steel built-up breech-loading gun, with a length of from thirty-five to forty-five times its diameter of bore, using slow-burning powder, having low initial pressures and giving a muzzle velocity from two thousand to twenty-five hundred feet per second, and special steel armor-piercing projectiles for the purpose of racking or breaking up the armor and then piercing the hull. This competition has indirectly opened up a new material of some twenty per centum greater strength when compared with wrought iron, known as mild steel, which naval architects are employing to enable them to produce lighter structures, and to use the weight saved in giving greater thickness to the armor, increased armament, or added power and speed, as the necessities of the design contemplated may demand. Shortly after the introduction of this material, or in 1882, the Congress of the United States appropriated for the construction of three cruisers and one dispatch boat, which are now familiar to us all under the names of the Chicago, Boston, Atlanta, and Dolphin; fortunately for our Government, its corps of naval constructors and engineers had by repeated visits to the ship-yards and gun factories abroad, and a close study of the principles involved in the new methods of construction, kept themselves fully

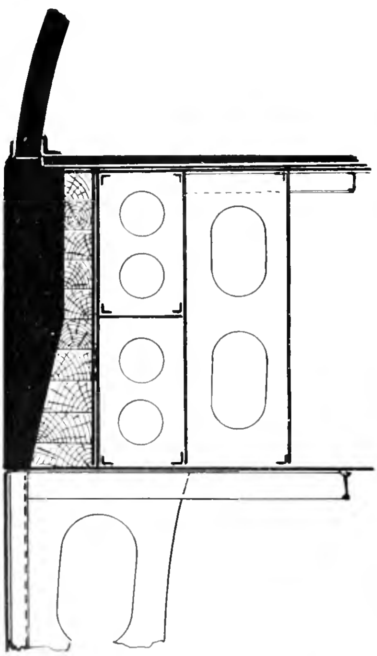


Fig. 2.—Iowa. Section through Armor.

abreast of the progress being made in shipbuilding, marine engineering, and naval artillery, and were thus enabled when the opportunity was given by Congress to promptly take up the work of rehabilitating the navy, and carry it forward successfully. Congress in its appropriation had stipulated that the new vessels were to be constructed of steel; this meant a considerable outlay in capital to the metal producers of the country, who, with the exception of some firms making a specialty of tool steel, had been engaged mainly in the manufacture of wrought iron. However, having full confidence in the determination of Congress to give the country a new navy, they did not hesitate to at once install plants capable of manufacturing steel suitable for shipbuilding and boiler construction, of steel of a higher grade for the construction of high-powered built-up guns, and of producing steel for armor plates weighing from thirty to forty tons each. It is worthy of note that these industries, built up within a decade under the stimulus given by the rebuilding of the navy, to-day challenge the world to produce better material. So rapid has been the progress of our manufacturers, and so fully have all demands upon them been met, that one of our shipbuilding firms is now constructing two mammoth steamers for the Inman International Line, whose ves-

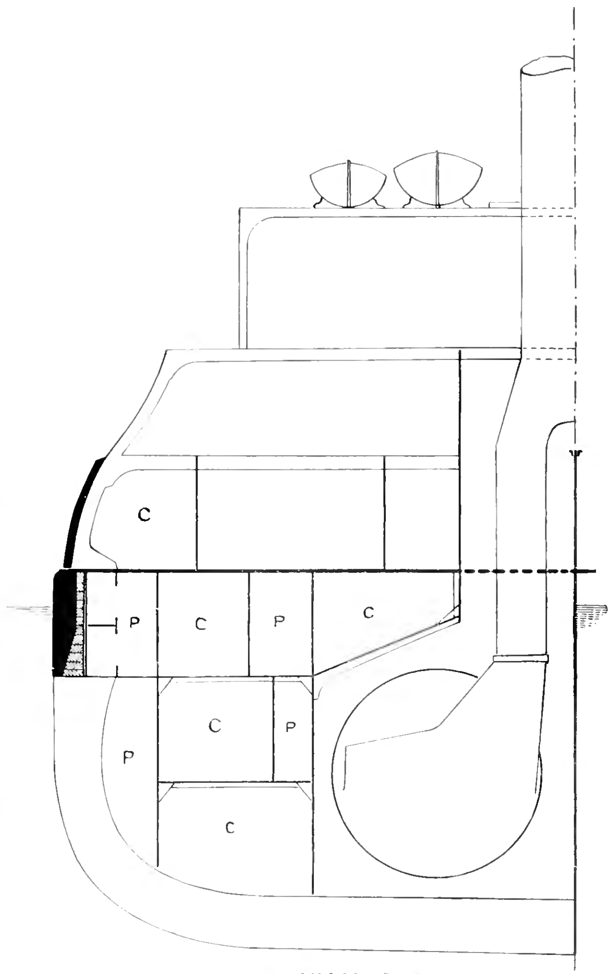


FIG. 3.—IOWA. Midship Section.
C, C, C, coal; P, P, P, passages.

sels have, since its organization, been constructed on the other side of the Atlantic.

The types of war vessels considered by naval authorities to be best suited to the needs of our service may be classed in general terms as battle-ships, armored cruisers, protected cruisers, harbor-defense monitors, gunboats, torpedo-boats (surface and submarine), and rams. The uses and functions of each type differ greatly; some of the more prominent may be broadly stated here.

Taking first the battle-ships, we find them to be, of all the types of war vessels, the most powerful in the feature of offense and defense; they are intended to stand and fight, to give and take blows like giants in a prize ring; and the reason can be plainly seen when we appreciate the fact that an enemy can bring his battle-ship within twelve miles of our large seaboard cities, and there taking up a position of vantage, secure from any attack by land, shell the city; the only vessel, then, that can dispute possession with him point by point is a ship of similar powers of doing battle, however successful an attack by torpedo-boat, either surface or submarine, may be when the conditions are suitable. The points, therefore, to be emphasized in the design are protection and armament, or the power to deliver heavy blows with the ability to withstand those of its antagonist; with these must be combined power to enable it to act on the offensive, such as speed, endurance, habitability, and form of hull that will insure seaworthiness.

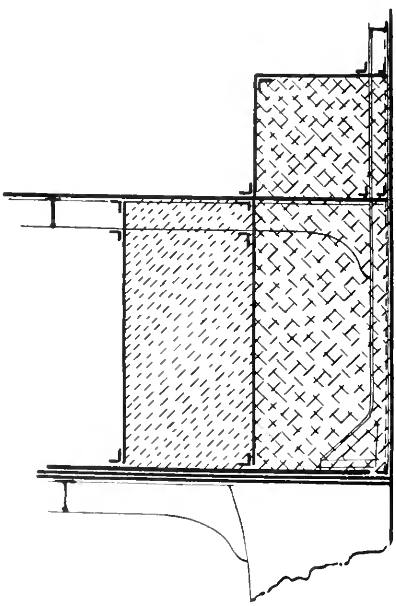


Fig. 4.—Iowa.
Section through Coffer Dams, etc.

As a purely harbor-defense vessel the monitor stands pre-eminent, the entire hull and battery being protected by armor, and at the same time offering such a small target that it is extremely difficult to hit; but its military value is very seriously impaired when in a seaway, by the short distance of the guns above the water, it being impossible to use them in a heavy sea. Perhaps the vessels most useful for all-around work are the armored cruisers, as they are intended to have great speed, great endurance, guns capable of coping with vessels inferior only to battle-ships, with a very considerable amount of protection afforded to the hull and

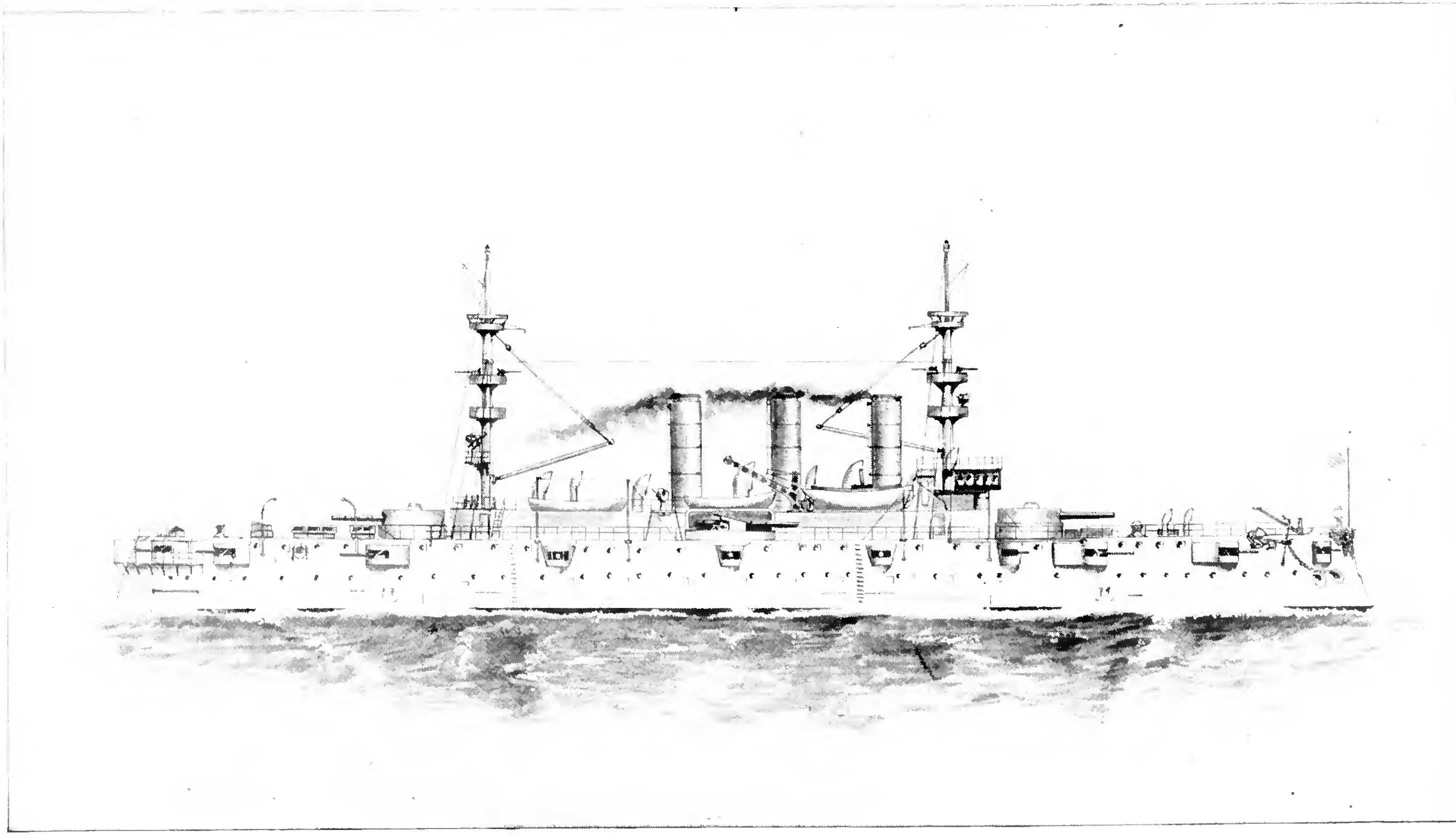


Fig. 5.—United States Steamer New York. Armored Cruiser.

armament; their function in war is to capture the commerce-destroyers of the enemy, to act as commerce-destroyers themselves, and to convoy and protect fleets of large and fast merchant vessels. To accomplish these purposes great speed is necessary, either to overtake or convoy swift merchantmen; great endurance or coal supply, to enable them to keep the sea for long periods on the path usually frequented by merchant vessels; and offensive and defensive power sufficient to enable them to successfully resist the attacks of vessels of their own class.

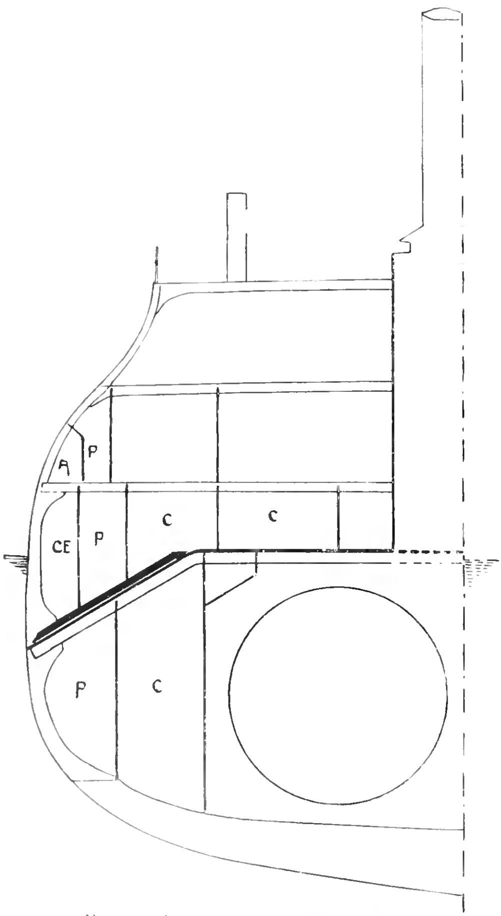


Fig. 6.—Brooklyn. Midship Section. A, air duct; CE, cellulose; C, C, C, coal; P, P, P, passages.

The type next in importance and general usefulness is styled the protected cruiser, or those whose only protection against injury consists of sloping armor decks of varying thickness, in combination with coffer dams filled with water-excluding material and closely divided compartments in the region of the line of flotation. The characteristics of this type are not capable of being so clearly defined as those already considered, as they include such widely differing vessels as the triple-screw Columbia of 7,350 tons displacement, the Olympia of 5,500 tons, down to cruisers of 2,000 and 3,000 tons displacement as represented by the Cincinnati and Detroit. Their function is a varied though exceedingly useful one; some are designed particularly for preying upon the commerce of an enemy so as to cripple its resources, the most notable examples being the Columbia of our own and the Blake of the British Navy.

Speed and endurance are the features emphasized, combined with guns of light caliber for dealing with unarmed vessels;

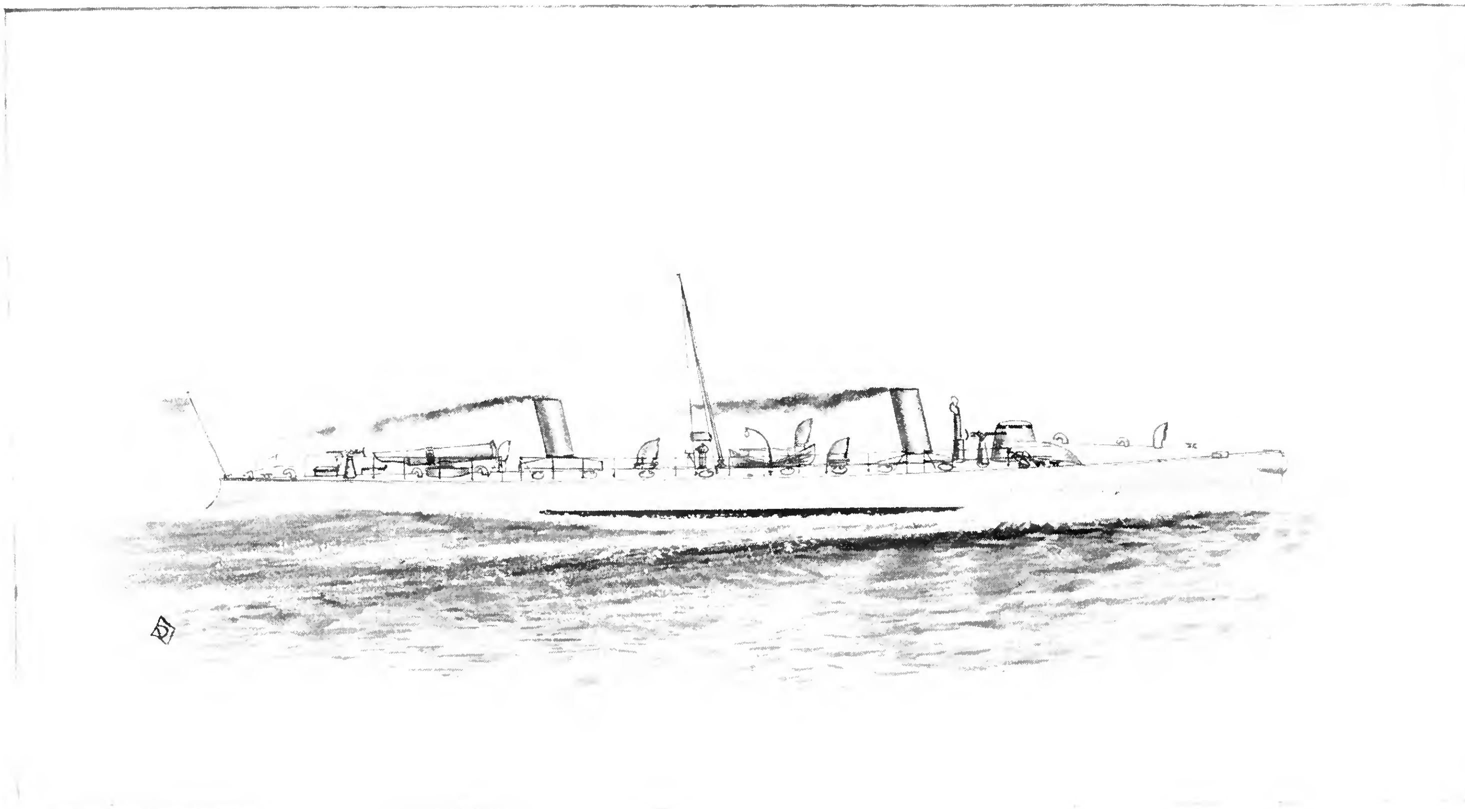


Fig. 7.—United States Torpedo Boat Ericsson.

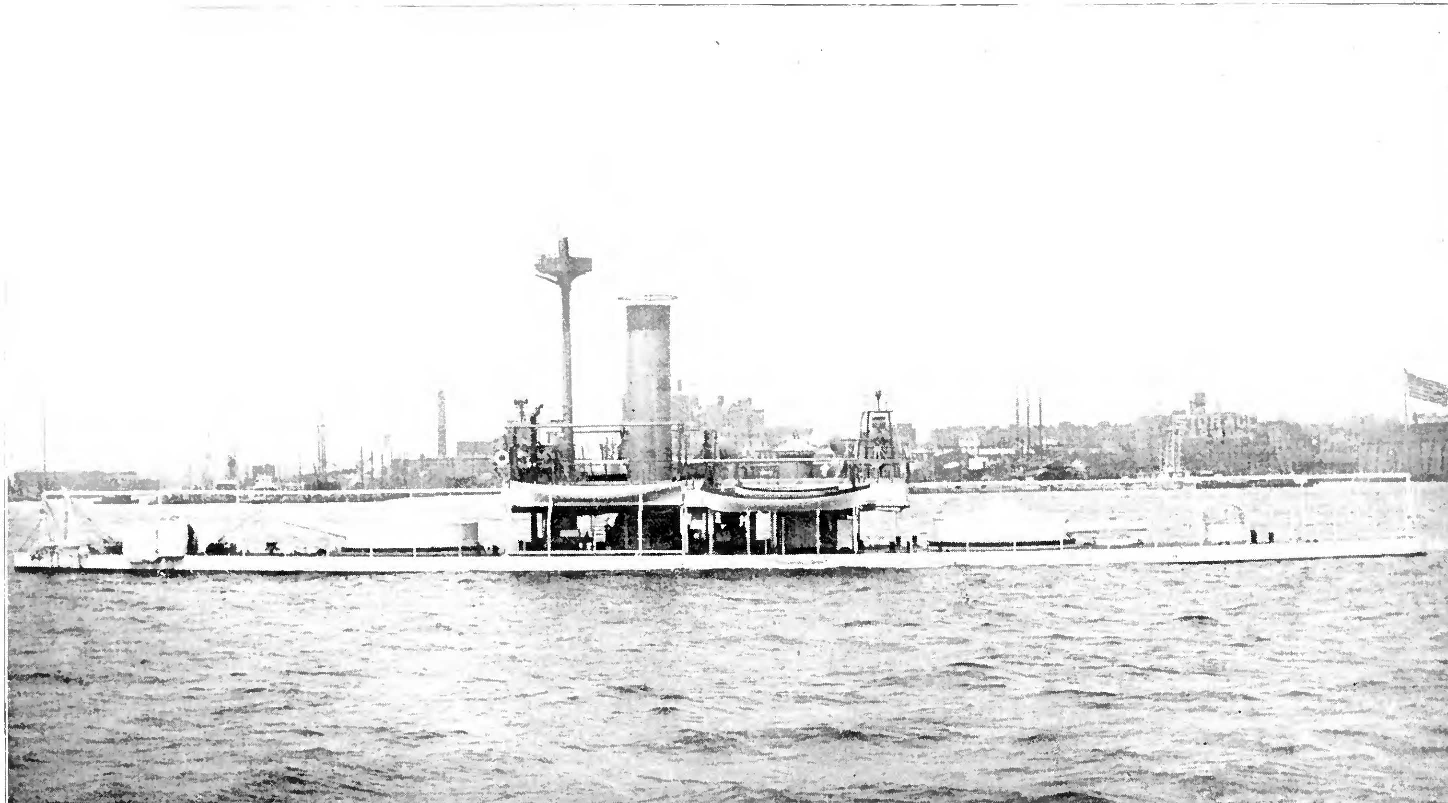


Fig. 8.—United States Steamer Miantonomoh. Monitor.

others again, like the Chicago, Newark, Baltimore, and San Francisco, are designed for purposes of general utility, such as protecting our mercantile interests abroad, the one feature emphasized being endurance, with those of speed, protection, and armament very fairly developed. Our gunboats of the Yorktown and Machias types are miniature cruisers, except that speed has been sacrificed to enable them to carry heavy batteries; at present they are constructed entirely of steel, although many fruitless efforts have been made to adopt in this class the style of construction known as composite—that is, all the parts of steel as is customary, except the outer covering of the hull, which is formed of wood planking coppered instead of steel plating. This system has been most earnestly and ably advocated by Chief Naval Constructor Philip Hichborn, and has formed the subject of special reports by him to the Navy Department, but the wording of the congressional appropriations has been such as to preclude its adoption.

The advantages to be gained are cheapness and ease of maintenance, freedom from fouling and consequent ease of propulsion, with the ability to keep the sea for long periods without being docked. All vessels of war are in a certain sense compromises between speed, endurance, protection, and armament; no one feature can be largely developed without corresponding sacrifices in the development of the others: for example, if great speed is required, it entails machinery of great power and weight with a large supply of coal; the weights, therefore, of the other main features must necessarily be reduced in order to emphasize that of speed; therefore, when Congress has appropriated for a certain type of vessel and fixed the limit of cost, a very careful study of all existing vessels of the desired type is made by the designing staff of the construction department, the particular requirements of the service are considered, the features to be emphasized determined, and the results embodied in a carefully prepared design. It is a very usual custom, and perhaps a natural one, for the press, when the design is made public, to compare it with some similar vessel of a foreign navy whose conditions of service are very dissimilar, sometimes to the seeming disadvantage of the proposed vessel, especially when such criticism may have been suggested by private builders who desire greater latitude in certain directions, and the general public may receive the impression that the best has not been attained; but to those who know the care and study given to the preparation of the design in view of the service required, and are able to comprehend fully its military value, the conclusion is very different. Taking, then, our battle-ships, we find the highest representative in the Iowa (Fig. 1), now building at the Messrs. Cramp's, which has a displacement of 11,250 tons, and carries a battery of four

12-inch, eight 8-inch, and ten 4-inch breech-loading guns, besides twenty machine guns and six tubes for discharging 18-inch automobile torpedoes. It is one thing for a vessel to carry a large battery capable of firing a tremendous weight of metal when all the manipulating apparatus is in perfect order, but quite another in these days of high explosives to have that battery and apparatus securely protected from the guns of its antagonist, therefore the 12-inch forty-four-ton guns of the Iowa are mounted in pairs in turrets having walls of solid steel fifteen inches thick, and protected from the water-line up by steel of the same thickness, which effectually protects the loading, turning, and controlling mechanisms. In order that these guns may be fought in heavy weather the forward turret is placed on a forecastle deck with the axis of the guns some twenty-five feet above the load line, and has a train of three hundred degrees, or only sixty less than a complete circle; the after 12-inch guns are mounted in the same manner, but on a deck seven feet nearer the load line. Both forward and after turrets are placed in the mid line of the vessel, in order to have a great train and be as free as possible from the motion due to rolling; the turrets are revolved by steam power at the rate of one revolution per minute. Some idea of the power of these guns may be obtained from the following data: The weight of one powder charge is four hundred and twenty-five pounds; that of the projectile, eight hundred and fifty pounds; its muzzle velocity, 2,100 feet, or four tenths of a mile per second; the muzzle energy, 25,985 foot tons, or capable of raising that amount one foot in a minute, with a penetration in wrought iron of 27·6 inches. The 8-inch guns are also mounted in turrets, having great range, and are protected by armor varying from ten inches to seven inches and a half in thickness; the ten 4-inch guns, each discharging projectiles of thirty-six pounds weight at the rate of ten rounds per minute, are protected by fixed segmental shields four inches thick.

While so much has been done to develop the battery and its protection, the features of defense, stability, speed, and endurance have received most careful attention; the magazines, boilers, engines, steering mechanism, etc., are all inclosed in a belt of steel, covering about sixty-five per cent of the load-line area, of a maximum thickness of fourteen inches, and extending fr m three feet above to five feet below the load line; at the upper edge of this is worked from side to side of the vessel a horizontal deck three inches thick (see Figs. 2 and 3); above this, to protect the stability, a steel belt four inches in thickness is worked to the main deck, and at the unarmored ends double coffer dams six feet wide, the outer one filled with obturating and the inner one with water-excluding material, are provided as shown in Fig. 4.

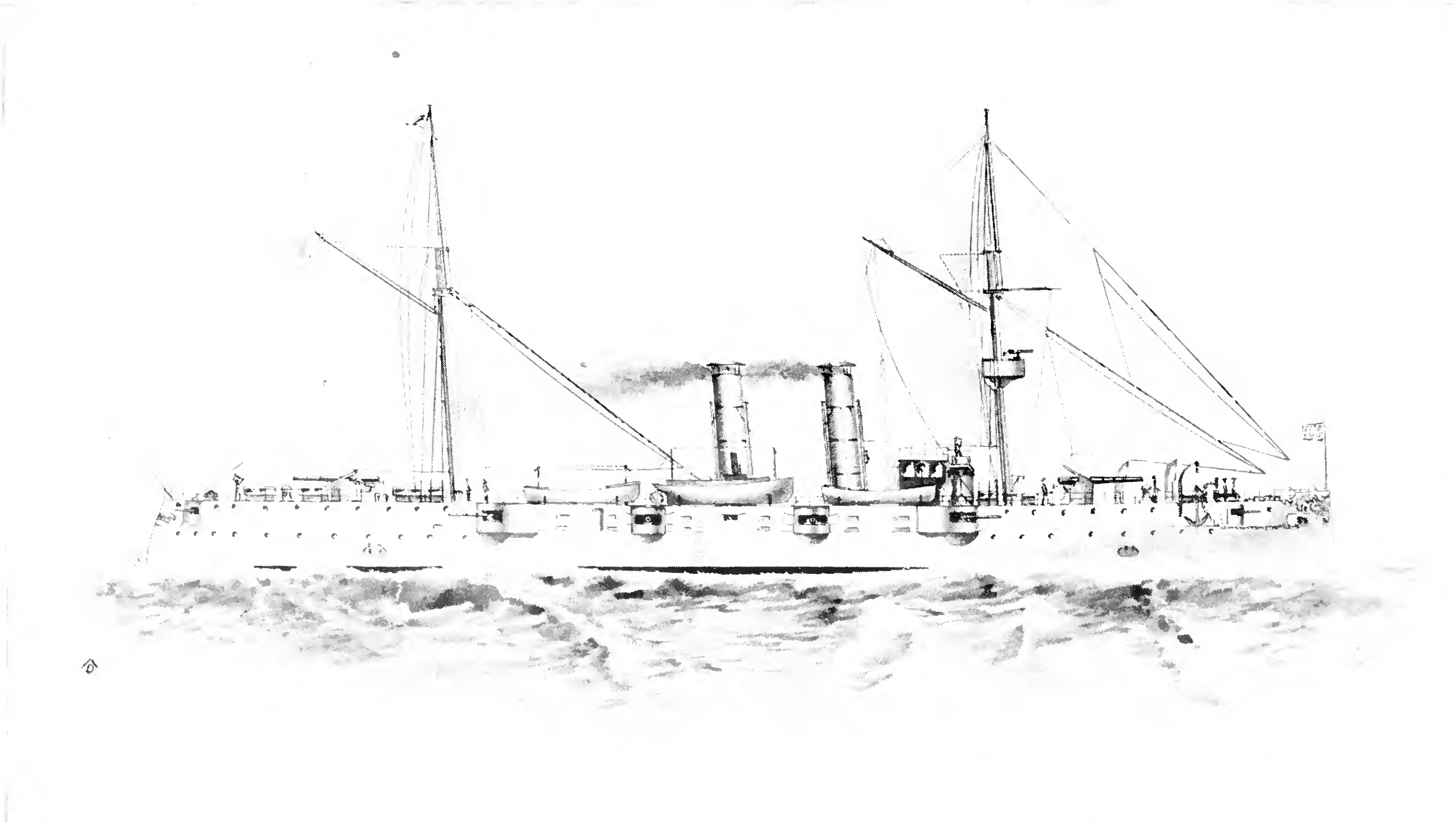


Fig. 9.—United States Steamer Cincinnati. Protected Cruiser.

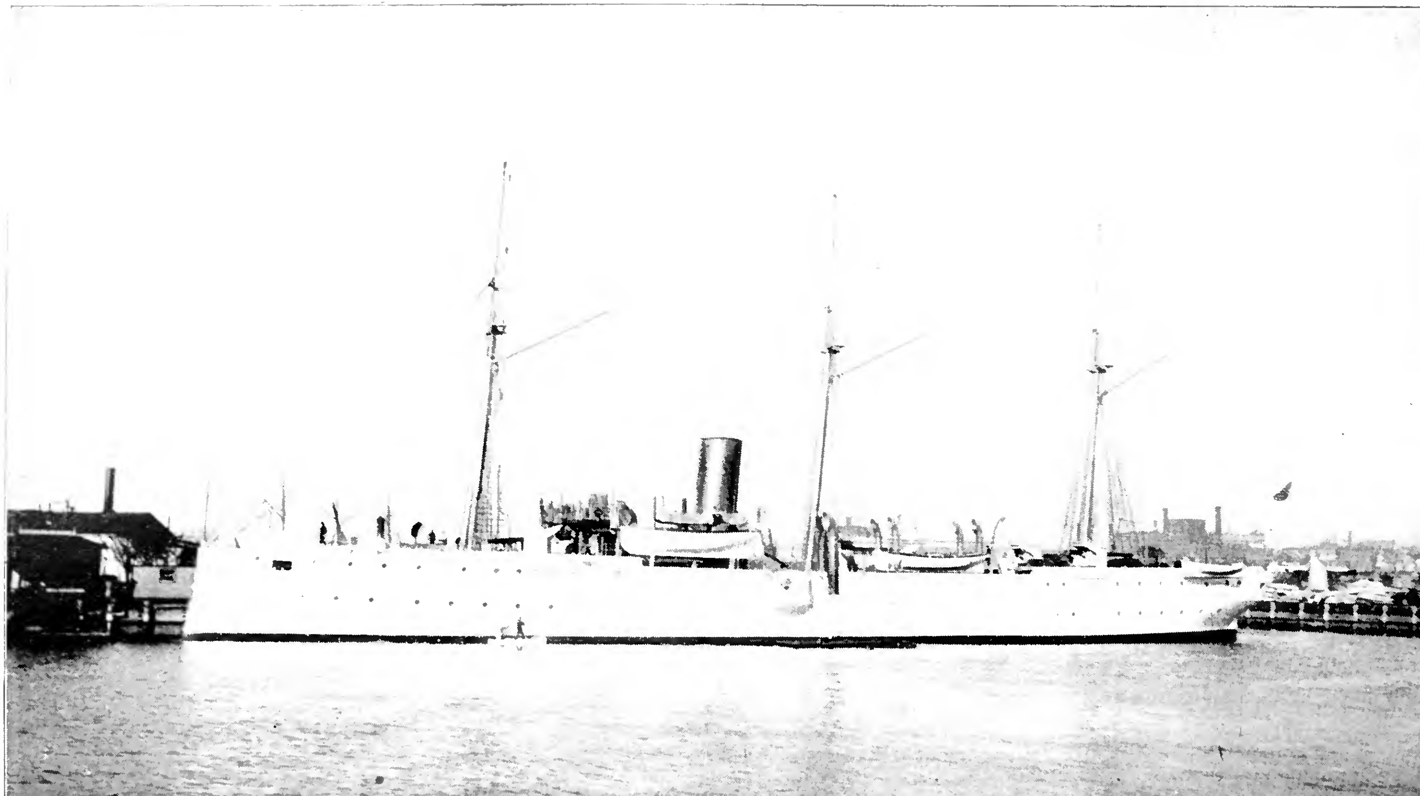


FIG. 10.—UNITED STATES STEAMER YORKTOWN. Gunboat.

Great care has been given the water-tight subdivision, both above and below the armor belt, in order to prevent a catastrophe such as that which befell the Victoria; especially above the armor belt, where the subdivision of that unfortunate vessel was very weak, has the Iowa received most careful attention. The machinery is capable of developing 11,000 horse power, and will propel the vessel at a speed of seventeen knots per hour; the engines are of the triple-expansion type, being inverted, direct acting, and surface-condensing, driving twin screws. The coal supply is sufficient when steaming at ten knots to admit of crossing the Atlantic and back without recoaling. The United States steamship New York (Fig. 5), which lately created so much enthusiasm on account of her remarkable development of speed, is of the armored-cruiser type; but the Brooklyn, now being built under contract, is a very distinct advance upon the general design of the New York, and will here be taken as the exponent of her type. We find her to be provided with sufficient power to drive her at the rate of twenty-one knots or twenty-four miles per hour, and to have a coal supply of 1,800 tons, which will give her a very large radius of action. The main battery carried is eight 8-inch and twelve 5-inch breech-loading rifles; the 8-inch guns are mounted in pairs in turrets, protected by steel armor seven and a half and five inches in thickness; the 5-inch guns and the battery of machine guns, eighteen in number, are protected by steel armor varying in thickness from four to two inches. The protection to the hull, machinery, and magazines is afforded by a steel deck of a maximum thickness of six inches, being five feet below the load line at its outboard edges, and sloping upward and inward to the height of the load line on the flat portions, as shown in Fig. 6.

Beneath this deck are placed engines, boilers, magazines, steering gear, and electrical generating plant, in fact all such parts as would be injured by and disable the vessel if exposed to the enemy's fire. To protect the stability an armored belt four inches in thickness is worked from the sloping armor to four feet above the load line for the space occupied by the engines and boilers, the object being to provide resistance sufficient to cause high-explosive shells to explode before entering the sides of the vessel. Inside of this and extending the whole length of the vessel is a coffer dam of obturating material, as shown in the outline midship section, Fig. 6, and the spaces both above and below the armor deck are closely subdivided by longitudinal and athwartship bulkheads into many compartments in which coal and stores are stowed, thus as far as possible, with the means now at the command of the naval architect, precluding the sinking of the vessel when injured.

A class of vessels of much interest, on account of their great destructive capabilities when the conditions are suitable, is the torpedo vessel, of which the Ericsson (Fig. 7), now building, is a representative; they are lightly constructed and provided with powerful machinery to enable them to attain great speed, reaching as high as twenty-eight to thirty-five miles per hour. They are armed principally with torpedo-launching tubes from which are ejected, by compressed air, automobile torpedoes, capable of traveling at a rate of speed of twenty knots per hour at a predetermined depth. The boat or launching tube is trained directly upon the target, and the torpedoes are expelled in a direct line toward it, certain automatic rudders being acted upon by hydrostatic pressure to enable them to keep their course. The head is fitted with a torpedo net-cutting device to enable the torpedo to pass through the net protecting the ship's side and to explode against the side by impact. The most noteworthy achievement by this class of vessels was the blowing up and sinking of the Blanco Encalada by the Almirante Lynch during the late Chilian struggle.

In closing this article it seems eminently proper to acknowledge the distinguished services and untiring zeal of ex-Chief Constructor Theodore D. Wilson, who for eleven years, or during the period of rehabilitation, has most ably shaped the general design and construction of the hulls of our war vessels.

EVOLUTION AND ETHICS.

By Prof. THOMAS H. HUXLEY, F. R. S.

[*Concluded.*]

LET us now set our faces westward, toward Asia Minor and Greece and Italy, to view the rise and progress of another philosophy, apparently independent, but no less pervaded by the conception of evolution.*

* In ancient times it was the fashion, even among the Greeks themselves, to derive all Greek wisdom from Eastern sources; not long ago it was as generally denied that Greek philosophy had any connection with Oriental speculation; it seems probable, however, that the truth lies between these extremes.

The Ionian intellectual movement does not stand alone. It is only one of several sporadic indications of the working of some powerful mental ferment over the whole of the area comprised between the Ægean and northern Hindustan during the eighth, seventh, and sixth centuries before our era. In these three hundred years prophetism attained its apogee among the Semites of Palestine; Zoroasterism grew and became the creed of a conquering race, the Iranic Aryans; Buddhism rose and spread with marvelous rapidity among the Aryans of Hindustan; while scientific naturalism took its rise among the Aryans of Ionia.

The sages of Miletus were pronounced evolutionists; and, however dark may be some of the sayings of Heracleitus of Ephesus, who was probably a contemporary of Gautama, no

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It would be difficult to find another three centuries which have given birth to four events of equal importance. All the principal existing religions of mankind have grown out of the first three, while the fourth is the little spring, now swollen into the great stream of positive science. So far as physical possibilities go, the prophet Jeremiah and the oldest Ionian philosopher might have met and conversed. If they had done so they would probably have disagreed a good deal; and it is interesting to reflect that their discussions might have embraced questions which at the present day are still hotly controverted.

The old Ionian philosophy, then, seems to be only one of many results of a stirring of the moral and intellectual life of the Aryan and the Semitic populations of western Asia. The conditions of this general awakening were doubtless manifold: but there is one which modern research has brought into great prominence. This is the existence of extremely ancient and highly advanced societies in the valleys of the Euphrates and of the Nile.

It is now known that more than a thousand—perhaps more than two thousand—years before the sixth century B. C., civilization had attained a relatively high pitch among the Babylonians and the Egyptians. Not only had painting, sculpture, architecture, and the industrial arts, reached a remarkable development, but in Chaldea, at any rate, a vast amount of knowledge had been accumulated and methodized in the departments of grammar, mathematics, astronomy, and natural history. Where such tracks of the scientific spirit are visible naturalistic speculation is rarely far off, though, so far as I know, no remains of an Accadian or Egyptian philosophy, properly so called, have yet been recovered.

Geographically, Chaldea occupied a central position among the oldest seats of civilization. Commerce, largely aided by the intervention of those colossal peddlers, the Phœnicians, had brought Chaldea into connection with all of them for a thousand years before the epoch at present under consideration. And in the ninth, eighth, and seventh centuries the Assyrian, the depository of Chaldean civilization, as the Macedonian and the Roman, at a later date, were the depositories of Greek culture, had added irresistible force to the other agencies for the wide distribution of Chaldean literature, art, and science.

I confess that I find it difficult to imagine that the Greek immigrants—who stood in somewhat the same relation to the Babylonians and the Egyptians as the later Germanic barbarians to the Romans of the Empire—should not have been immensely influenced by the new life with which they became acquainted. But there is abundant direct evidence of the magnitude of this influence in certain spheres. I suppose it is not doubted that the Greek went to school with the Oriental for his primary instruction in reading, writing, and arithmetic, and that Semitic theology supplied him with some of his mythological lore. Nor does there now seem to be any question about the large indebtedness of Greek art to that of Chaldea and that of Egypt.

But the manner of that indebtedness is very instructive. The obligation is clear, but its limits are no less definite. Nothing better exemplifies the indomitable originality of the Greeks than the relations of their art to that of the Orientals. Far from being subdued into mere imitators by the technical excellence of their teachers, they lost no time in bettering the instruction they received, using their models as mere stepping-stones on the way to those unsurpassed and unsurpassable achievements which are all their own. The shibboleth of Art is the human figure. The ancient Chaldeans and Egyptians, like the modern Japanese, did wonders in the representation of birds and quadrupeds; they even attained to something more than respectability in human portraiture. But their utmost efforts never brought them within range of the best Greek embodiments of the grace of womanhood, or of the severer beauty of manhood.

It is worth while to consider the probable effect upon the acute and critical Greek mind of the conflict of ideas, social, political, and theological, which arose out of the conditions

better expressions of the essence of the modern doctrine of evolution can be found than are presented by some of his pithy aphorisms and striking metaphors.* Indeed, many of my present

of life in the Asiatic colonies. The Ionian polities had passed through the whole gamut of social and political changes, from patriarchal and occasionally oppressive kingship to rowdy and still more burdensome mobship—no doubt with infinitely eloquent and copious argumentation on both sides at every stage of their progress toward that arbitrament of force which settles most political questions. The marvelous speculative faculty, latent in the Ionian, had come in contact with Mesopotamian, Egyptian, Phœnician theologies and cosmogonies; with the illuminati of Orphism and the fanatics and dreamers of the Mysteries; possibly with Buddhism and Zoroasterism; possibly even with Judaism. And it has been observed that the mutual contradictions of antagonistic supernaturalisms are apt to play a large part among the generative agencies of naturalism.

Thus, various external influences may have contributed to the rise of philosophy among the Ionian Greeks of the sixth century. But the assimilative capacity of the Greek mind—its power of Hellenizing whatever it touched—has here worked so effectually that, so far as I can learn, no indubitable traces of such extraneous contributions are now allowed to exist by the most authoritative historians of philosophy. Nevertheless, I think it must be admitted that the coincidences between the Heracleito-stoical doctrines and those of the older Hindu philosophy are extremely remarkable. In both the cosmos pursues an eternal succession of cyclical changes. The great year, answering to the Kalpa, covers an entire cycle from the origin of the universe as a fluid to its dissolution in fire—"Humor initium, ignis exitus mundi," as Seneca has it. In both systems there is immanent in the cosmos a source of energy, Brahma, or the Logos, which works according to fixed laws. The individual soul is an efflux of this world-spirit, and returns to it. Perfection is attainable only by individual effort through ascetic discipline, and is rather a state of painlessness than of happiness, if indeed it can be said to be a state of anything save the negation of perturbing emotion. The hatchment motto "In Cœlo Quies" would serve both Hindu and Stoic, and absolute quiet is not easily distinguishable from annihilation.

Zoroasterism, which geographically occupies a position intermediate between Hellenism and Hinduism, agrees with the latter in recognizing the essential evil of the cosmos, but differs from both in its intensely anthropomorphic personification of the two antagonistic principles, to the one of which it ascribes all the good, and to the other all the evil. In fact, it assumes the existence of two worlds, one good and one bad; the latter created by the evil power for the purpose of damaging the former. The existing cosmos is a mere mixture of the two, and the "last judgment" is a root and branch extirpation of the work of Ahriman.

* There is no snare in which the feet of a modern student of ancient lore are more easily entangled than that which is spread by the similarity of the language of antiquity to modern modes of expression. I do not presume to interpret the obscurest of Greek philosophers; all I wish is to point out that his words, in the sense accepted by competent interpreters, fit modern ideas singularly well.

So far as the general theory of evolution goes, there is no difficulty. The aphorism about the river; the figure of the child playing on the shore; the kingship and fatherhood of strife, seem decisive. The ὁδὸς ἄνω κάτω μίη expresses with singular aptness the cyclical aspect of the one process of organic evolution in individual plants and animals; yet it may be a question whether the Heracleitean strife included any distinct conception of the struggle for existence. Again, it is tempting to compare the part played by the Heracleitean "fire" with that ascribed by the moderns to heat, or rather to that cause of motion of which heat is one expression; and a little ingenuity might find a foreshadowing of the doctrine of the conservation of energy in the saying that all the things are changed into fire and fire into all things, as gold into goods and goods into gold.

auditors must have observed that more than once I have borrowed from him in the brief exposition of the theory of evolution with which this discourse commenced.

But when the focus of Greek intellectual activity shifted to Athens, the leading minds concentrated their attention upon ethical problems. For saking the study of themacrocosm for that of the microcosm, they lost the key to the thought of the great Ephesian, which I imagine is more intelligible to us than it was to Socrates or to Plato. Socrates more especially set the fashion of a kind of inverse agnosticism, by teaching that the problems of physics lie beyond the reach of the human intellect; that the attempt to solve them is essentially vain; that the one worthy object of investigation is the problem of ethical life; and his example was followed by the Cynics and the later Stoics. Even the comprehensive knowledge and the penetrating intellect of Aristotle failed to suggest to him that in holding the eternity of the world within its present range of mutation, he was making a retrogressive step. The scientific heritage of Heracleitus passed into the hands neither of Plato nor of Aristotle, but into those of Democritus. But the world was not yet ready to receive the great conceptions of the philosopher of Abdera. It was reserved for the Stoics to return to the track marked out by the earlier philosophers, and, professing themselves disciples of Heracleitus, to develop the idea of evolution systematically. In doing this, they not only omitted some characteristic features of their master's teaching, but they made additions altogether foreign to it. One of the most influential of these importations was the transcendental theism which had come into vogue. The restless, fiery energy, operating according to law, out of which all things emerge and into which they return, in the endless successive cycles of the great year; which creates and destroys worlds as a wanton child builds up and, anon, levels sand castles on the seashore, was metamorphosed into a material world-soul, and decked out with all the attributes of ideal Divinity; not merely with infinite power and transcendent wisdom, but with absolute goodness.

The consequences of this step were momentous; for, if the cosmos is the effect of an immanent, omnipotent, and infinitely beneficent cause, the existence in it of real evil, still less of necessarily inherent evil, is plainly inadmissible.* Yet the universal

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* Pope's lines in the Essay on Man (Ep. i, 267, 268),

> "All are but parts of one stupendous whole,
> Whose body Nature is, and God the soul,"

simply paraphrase Seneca's "quem in hoc mundo locum deus obtinet, hunc in homine animus: quod est illic materia, id nobis corpus est" (Ep. lxv, 24) [And what God is in the world, such is the mind or soul in man; what in the world is *matter*, in us is body.—

experience of mankind testified then as now that, whether we look within us or without us, evil stares us in the face on all sides; that if anything is real, pain and sorrow and wrong are realities.

It would be a new thing in history if *a priori* philosophers were daunted by the factious opposition of experience, and the Stoics were the last men to allow themselves to be beaten by mere facts. "Give me a doctrine and I will find the reasons for it," said Chrysippus. So they perfected, if they did not invent, that ingenious and plausible form of pleading, the Theodicy, for the purpose of showing, firstly, that there is no such thing as evil; secondly, that if there is, it is the necessary correlate of good; and moreover, that it is either due to our own fault or inflicted for our benefit. Theodicies have been very popular in their time, and I believe that a numerous, though somewhat dwarfed, progeny of them still survives. So far as I know, they are all variations of the theme set forth in those famous six lines of the Essay on Man, in which Pope sums up Bolingbroke's reminiscences of stoical and other speculations of this kind:

> "All nature is but art, unknown to thee;
> All chance, direction which thou canst not see;
> All discord, harmony not understood;
> All partial evil, universal good;
> And spite of pride, in erring reason's spite,
> One truth is clear: whatever is is right."

Yet surely, if there are few more important truths than those enunciated in the first triad, the second is open to very grave objections. That there is a "soul of good in things evil" is unquestionable; nor will any wise man deny the disciplinary value of pain and sorrow. But these considerations do not help us to see why the immense multitude of irresponsible sentient beings which can not profit by such discipline should suffer; nor why, among the endless possibilities open to omnipotence—that of sinless, happy existence among the rest—the actuality in which sin and misery abound should be that selected. Surely it is mere cheap rhetoric to call arguments which have never yet been answered

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Morell's translation], which again is a Latin version of the old Stoical doctrine, εἰς ἅπαν τοῦ κόσμου μέρος διήκει ὁ νοῦς, καθάπερ ἀφ' ἡμῶν ἡ ψυχή.

So far as testimony for the universality of what ordinary people call "evil" goes, there is nothing better than the writings of the Stoics themselves. They might serve as a storehouse for the epigrams of the ultra-pessimists. Heracleitus (*circa* 500 B. C.) says just as hard things about ordinary humanity as his disciples centuries later; and there really seems no need to seek for the causes of this dark view of life in the circumstances of the time of Alexander's successors or of the early emperors of Rome. To the man with an ethical ideal, the world, including himself, will always seem full of evil.

by even the meekest and the least rational of optimists suggestions of the pride of reason. As to the concluding aphorism, its fittest place would be as an inscription in letters of mud over the portal of some "stye of Epicurus";* for that is where the logical application of it to practice would land men, with every aspiration stifled and every effort paralyzed. Why try to set right what is right already? Why strive to improve the best of all possible worlds? Let us eat and drink, for as to-day all is right, so to-morrow all will be.

But the attempt of the Stoics to blind themselves to the reality of evil, as a necessary concomitant of the cosmic process, had less success than that of the Indian philosophers to exclude the reality of good from their purview. Unfortunately, it is much easier to shut one's eyes to good than to evil. Pain and sorrow knock at our doors more loudly than pleasure and happiness, and the prints of their heavy footsteps are less easily effaced. Before the grim realities of practical life the pleasant fictions of optimism vanished. If this were the best of all possible worlds, it nevertheless proved itself a very inconvenient habitation for the ideal sage.

The stoical summary of the whole duty of man, "Live according to Nature," would seem to imply that the cosmic process is an exemplar for human conduct. Ethics would thus become applied natural history. In fact, a confused employment of the maxim in this sense has done immeasurable mischief in later times. It has furnished an axiomatic foundation for the philosophy of philosophasters and for the moralizing of sentimentalists. But the Stoics were, at bottom, not merely noble but sane men; and if we look closely into what they really meant by this ill-used phrase, it will be found to present no justification for the mischievous conclusions that have been deduced from it.

In the language of the Stoa, "Nature" was a word of many meanings. There was the "Nature" of the cosmos and the "Nature" of man. In the latter, the animal "nature," which man shares with a moiety of the living part of the cosmos, was distinguished from a higher "nature." Even in this higher nature there were grades of rank. The logical faculty is an instrument which may be turned to account for any purpose. The passions and the emotions are so closely tied to the lower nature that they may be considered to be pathological rather than normal phenomena. The one supreme, hegemonic faculty which con-

* I use the well-known phrase, but decline responsibility for the libel upon Epicurus, whose doctrines were far less compatible with existence in a stye than those of the Cynics. If it were steadily borne in mind that the conception of the "flesh" as the source of evil, and that the great saying, "Initium est salutis notitia peccati" [the beginning of salvation is the recognition of sin], are the property of Epicurus, fewer illusions about Epicureanism would pass muster for accepted truth.

stitutes the essential "nature" of man, is most nearly represented by that which, in the language of a later philosophy, has been called the pure reason. It is this "nature" which holds up the ideal of the supreme good and demands absolute submission of the will to its behests. It is this which commands all men to love one another, to return good for evil, to regard one another as fellow-citizens of one great state. Indeed, seeing that the progress toward perfection of a civilized state, or polity, depends on the obedience of its members to these commands, the Stoics sometimes termed the pure reason the "political" nature. Unfortunately, the sense of the adjective has undergone so much modification that the application of it to that which commands the sacrifice of self to the common good would now sound almost grotesque.*

But what part is played by the theory of evolution in this view of ethics? So far as I can discern, the ethical system of the Stoics, which is essentially intuitive, and reverences the categorical imperative as strongly as that of any later moralists, might have been just what it was if they had held any other theory—whether that of special creation, on the one side, or that of the eternal existence of the present order, on the other.† To the Stoic, the

* The Stoics said that man was a ζῷον λογικὸν πολιτικὸν φιλάλληλον, or a rational, a political, and an altruistic or philanthropic animal. In their view, his higher nature tended to develop in these three directions as a plant tends to grow up into its typical form. Since, without the introduction of any consideration of pleasure or pain, whatever thwarted the realization of its type by the plant might be said to be bad, and whatever helped it good; so virtue, in the Stoical sense, as the conduct which tended to the attainment of the rational, political, and philanthropic ideal, was good in itself and irrespectively of its emotional concomitants.

Man is an "animal sociale communi bono genitum." The safety of society depends upon practical recognition of the fact. "Salva autem esse societas nisi custodia et amore partium non possit," says Seneca. (De Ira, ii, 31.) [The safety of society depends upon the love and care of its component parts.]

† The importance of the physical doctrine of the Stoics lies in its clear recognition of the universality of the law of causation with its corollary, the order of Nature: the exact form of that order is an altogether secondary consideration.

Many ingenious persons now appear to consider that the incompatibility of pantheism, of materialism, and of any doubt about the immortality of the soul, with religion and morality, is to be held as an axiomatic truth. I confess that I have a certain difficulty in accepting this dogma. For the Stoics were notoriously materialists and pantheists of the most extreme character; and while no strict stoic believed in the eternal duration of the individual soul, some even denied its persistence after death. Yet it is equally certain that of all Gentile philosophies, Stoicism exhibits the highest ethical development, is animated by the most religious spirit, and has exerted the profoundest influence upon the moral and religious development not merely of the best men among the Romans, but among the moderns down to our own day.

Seneca was claimed as a Christian and placed among the saints by the fathers of the early Christian Church; and the genuineness of a correspondence between him and the apostle Paul has been hotly maintained in our own time by orthodox writers. That the

cosmos had no importance for the conscience, except in so far as he chose to think it a pedagogue to virtue. The pertinacious optimism of our philosophers hid from them the actual state of the case. It prevented them from seeing that cosmic nature is no school of virtue, but the headquarters of the enemy of ethical nature. The logic of facts was necessary to convince them that the cosmos works through the lower nature of man, not for righteousness, but against it. And it finally drove them to confess that the existence of their ideal "wise man" was incompatible with the nature of things; that even a passable approximation to that ideal was to be attained only at the cost of renunciation of the world and mortification, not merely of the flesh, but of all human affections. The state of perfection was that "apatheia"* in which desire, though it may still be felt, is powerless to move the will, reduced to the sole function of executing the commands of pure reason. Even this residuum of activity was to be regarded as a temporary loan—as an efflux of the divine, world-pervading spirit, chafing at its imprisonment in the flesh, until such time as death enabled it to return to its source in the all-pervading logos.

I find it difficult to discover any very great difference between Apatheia and Nirvana, except that stoical speculation agrees with

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letters, as we possess them, are worthless forgeries is obvious, and writers as wide apart as Baur and Lightfoot agree that the whole story is devoid of foundation.

The dissertation of the late Bishop of Durham (Lightfoot, Epistle to the Philippians) is particularly worthy of study, apart from this question, on account of the evidence which it supplies of the numerous similarities of thought between Seneca and the writer of the Pauline epistles. When it is remembered that the writer of the Acts puts a quotation from Aratus, or Cleanthes, into the mouth of the apostle, and that Tarsus was a great seat of philosophical and especially stoical learning (Chrysippus himself was a native of the adjacent town of Sôli) there is no difficulty in understanding the origin of these resemblances. See, on this subject, Sir Alexander Grant's dissertation in his edition of The Ethics of Aristotle (where there is an interesting reference to the stoical character of Bishop Butler's ethics), the concluding pages of Dr. Weygoldt's instructive little work, Die Philosophie der Stoa, and Aubertin's Sénèque et Saint Paul.

It is surprising that a writer of Dr. Lightfoot's stamp should speak of Stoicism as a philosophy of "despair." Surely, rather, it was a philosophy of men who, having cast off all illusions and the childishness of despair among them, were minded to endure in patience whatever conditions the cosmic process might create, so long as those conditions were compatible with the progress toward virtue, which alone for them conferred a worthy object on existence. There is no note of despair in the stoical declaration that the perfected "wise man" is the equal of Zeus in everything but the duration of his existence. And in my judgment there is as little pride about it—often as it serves for the text of discourses on stoical arrogance. Grant the stoical postulate that there is no good except virtue; grant that the perfected wise man is altogether virtuous, in consequence of being guided in all things by the reason, which is an effluence of Zeus, and there seems no escape from the stoical conclusion.

* Our "apathy" carries such a different set of connotations from its Greek original that I have ventured on using the latter as a technical term.

pre-Buddhistic philosophy, rather than with the teachings of Gautama, in so far as it postulates a permanent substance equivalent to "Brahma" and "Atman"; and that, in stoical practice, the adoption of the life of the mendicant cynic was held to be more a counsel of perfection than an indispensable condition of the higher life.

Thus the extremes touch. Greek thought and Indian thought set out from ground common to both, diverge widely, develop under very different physical and moral conditions, and finally converge to practically the same end.

The Vedas and the Homeric epos set before us a world of rich and vigorous life, full of joyous fighting men—

> "That ever with a frolic welcome took
> The thunder and the sunshine," . . . .

and who were ready to brave the very gods themselves when their blood was up. A few centuries pass away and, under the influence of civilization, the descendants of these men are "sicklied o'er with the pale cast of thought"—frank pessimists, or at best, make-believe optimists. The courage of the warlike stock may be as hardly tried as before, perhaps more hardly, but the enemy is self. The hero has become a monk. The man of action is replaced by the quietist, whose highest aspiration is to be the passive instrument of the divine Reason. By the Tiber, as by the Ganges, ethical man admits that the cosmos is too strong for him; and, destroying every bond which ties him to it by ascetic discipline, he seeks salvation in absolute renunciation.*

Modern thought is making a fresh start from the base whence Indian and Greek philosophy set out; and, the human mind being very much what it was six and twenty centuries ago, there is no ground for wonder if it presents indications of a tendency to move along the old lines to the same results.

We are more than sufficiently familiar with modern pessimism, at least as a speculation; for I can not call to mind that any of its present votaries have sealed their faith by assuming the rags and the bowl of the mendicant Bhikku, or the cloak and the wallet of the Cynic. The obstacles placed in the way of sturdy vagrancy by an unphilosophical police have, perhaps, proved too formidable for philosophical consistency. We also know modern speculative

* Many of the stoical philosophers recommended their disciples to take an active share in public affairs, and in the Roman world, for several centuries, the best public men were strongly inclined to Stoicism. Nevertheless, the logical tendency of Stoicism seems to me to be fulfilled only in such men as Diogenes and Epictetus.

optimism, with its perfectibility of the species, reign of peace, and lion and lamb transformation scenes; but one does not hear so much of it as one did forty years ago; indeed, I imagine it is to be met with more commonly at the tables of the healthy and wealthy than in the congregations of the wise. The majority of us, I apprehend, profess neither pessimism nor optimism. We hold that the world is neither so good nor so bad as it conceivably might be, and as most of us have reason, now and again, to discover that it can be. Those who have failed to experience the joys that make life worth living are, probably, in as small a minority as those who have never known the griefs that rob existence of its savor and turn its richest fruits into mere dust and ashes.

Further, I think I do not err in assuming that, however diverse their views on philosophical and religious matters, most men are agreed that the proportion of good and evil in life may be very sensibly affected by human action. I never heard anybody doubt that the evil may be thus increased or diminished, and it would seem to follow that good must be similarly susceptible of addition or subtraction. Finally, to my knowledge, nobody professes to doubt that, so far forth as we possess a power of bettering things, it is our paramount duty to use it and to train all our intellect and energy to this supreme service of our kind.

Hence the pressing interest of the question, to what extent modern progress in natural knowledge and, more especially, the general outcome of that progress in the doctrine of evolution, is competent to help us in the great work of helping one another.

The propounders of what are called the "ethics of evolution," when the "evolution of ethics" would usually better express the object of their speculations, adduce a number of more or less interesting facts and more or less sound arguments, in favor of the origin of the moral sentiments, in the same way as other natural phenomena, by a process of evolution. I have little doubt, for my own part, that they are on the right track; but as the immoral sentiments have no less been evolved, there is so far as much natural sanction for the one as the other. The thief and the murderer follow Nature just as much as the philanthropist. Cosmic evolution may teach us how the good and the evil tendencies of man may have come about, but in itself it is incompetent to furnish any better reason why what we call good is preferable to what we call evil than we had before. Some day, I doubt not, we shall arrive at an understanding of the evolution of the æsthetic faculty; but all the understanding in the world will neither increase nor diminish the force of the intuition that this is beautiful and that is ugly.

There is another fallacy which appears to me to pervade the so-called "ethics of evolution." It is the notion that because, on the whole, animals and plants have advanced in perfection of organization by means of the struggle for existence and the consequent "survival of the fittest"; therefore men in society, men as ethical beings, must look to the same process to help them toward perfection. I suspect that this fallacy has arisen out of the unfortunate ambiguity of the phrase "survival of the fittest." "Fittest" has a connotation of "best," and about "best" there hangs a moral flavor. In cosmic Nature, however, what is "fittest" depends upon the conditions. Long since, I ventured to point out that if our hemisphere were to cool again, the survival of the fittest might bring about, in the vegetable kingdom, a population of more and more stunted and humbler and humbler organisms, until the "fittest" that survived might be nothing but lichens, diatoms, and such microscopic organisms as those which give red snow its color; while, if it became hotter, the pleasant valleys of the Thames and Isis might be uninhabitable by any animated beings save those that flourish in a tropical jungle. They, as the fittest, the best adapted to the changed conditions, would survive.

Men in society are undoubtedly subject to the cosmic process. As among other animals, multiplication goes on without cessation and involves severe competition for the means of support. The struggle for existence tends to eliminate those less fitted to adapt themselves to the circumstances of their existence. The strongest, the most self-assertive, tend to tread down the weaker. But the influence of the cosmic process on the evolution of society is the greater the more rudimentary its civilization. Social progress means a checking of the cosmic process at every step and the substitution for it of another, which may be called the ethical process; the end of which is not the survival of those who may happen to be the fittest, in respect of the whole of the conditions which exist, but of those who are ethically the best.*

* Of course, strictly speaking, social life and the ethical process, in virtue of which it advances toward perfection, are part and parcel of the general process of evolution, just as the gregarious habit of innumerable plants and animals, which has been of immense advantage to them, is so. A hive of bees is an organic polity—a society in which the part played by each member is determined by organic necessities. Queens, workers, and drones are, so to speak, castes, divided from one another by marked physical barriers. Among birds and mammals, societies are formed, of which the bond in many cases seems to be purely psychological; that is to say, it appears to depend upon the liking of the individuals for one another's company. The tendency of individuals to over self-assertion is kept down by fighting. Even in these rudimentary forms of society, love and fear come into play and enforce a greater or less renunciation of self-will. To this extent the general cosmic process begins to be checked by a rudimentary ethical process, which is, strictly speaking, part of the former just as the "governor" in a steam engine is part of the mechanism of the engine.

As I have already urged, the practice of that which is ethically best—what we call goodness or virtue—involves a course of conduct which, in all respects, is opposed to that which leads to success in the cosmic struggle for existence. In place of ruthless self-assertion it demands self-restraint; in place of thrusting aside, or treading down, all competitors, it requires that the individual shall not merely respect, but shall help his fellows; its influence is directed, not so much to the survival of the fittest, as to the fitting of as many as possible to survive. It repudiates the gladiatorial theory of existence. It demands that each man who enters into the enjoyment of the advantages of a polity shall be mindful of his debt to those who have laboriously constructed it; and shall take heed that no act of his weakens the fabric in which he has been permitted to live. Laws and moral precepts are directed to the end of curbing the cosmic process and reminding the individual of his duty to the community, to the protection and influence of which he owes, if not existence itself, at least the life of something better than a brutal savage.

It is from neglect of these plain considerations that the fanatical individualism of our time attempts to apply the analogy of cosmic Nature to society. Once more we have a misapplication of the stoical injunction to follow Nature; the duties of the individual to the state are forgotten and his tendencies to self-assertion are dignified by the name of rights. It is seriously debated whether the members of a community are justified in using their combined strength to constrain one of their number to contribute his share to the maintenance of it; or even to prevent him from doing his best to destroy it. The struggle for existence, which has done such admirable work in cosmic Nature, must, it appears, be equally beneficent in the ethical sphere. Yet, if that which I have insisted upon is true; if the cosmic process has no sort of relation to moral ends; if the imitation of it by man is inconsistent with the first principles of ethics; what becomes of this surprising theory?

Let us understand, once for all, that the ethical progress of society depends, not on imitating the cosmic process, still less in running away from it, but in combating it. It may seem an audacious proposal thus to pit the microcosm against the macrocosm and to set man to subdue Nature to his higher ends; but, I venture to think that the great intellectual difference between the ancient times with which we have been occupied and our day, lies in the solid foundation we have acquired for the hope that such an enterprise may meet with a certain measure of success.

The history of civilization details the steps by which men have succeeded in building up an artificial world within the cosmos. Fragile reed as he may be, man, as Pascal says, is a thinking

reed: * there lies within him a fund of energy, operating intelligently and so far akin to that which pervades the universe, that it is competent to influence and modify the cosmic process. In virtue of his intelligence, the dwarf bends the Titan to his will. In every family, in every polity that has been established, the cosmic process in man has been restrained and otherwise modified by law and custom; in surrounding Nature, it has been similarly influenced by the art of the shepherd, the agriculturist, the artisan. As civilization has advanced, so has the extent of this interference increased; until the organized and highly developed sciences and arts of the present day have endowed man with a command over the course of non-human nature greater than that once attributed to the magicians. The most impressive, I might say startling, of these changes have been brought about in the course of the last two centuries; while a right comprehension of the process of life and of the means of influencing its manifestations is only just dawning upon us. We do not yet see our way beyond generalities; and we are befogged by the obtrusion of false analogies and crude anticipations. But Astronomy, Physics, Chemistry, have all had to pass through similar phases, before they reached the stage at which their influence became an important factor in human affairs. Physiology, Psychology, Ethics, Political Science, must submit to the same ordeal. Yet it seems to me irrational to doubt that, at no distant period, they will work as great a revolution in the sphere of practice.

The theory of evolution encourages no millennial anticipations. If, for millions of years, our globe has taken the upward road, yet, some time, the summit will be reached and the downward route will be commenced. The most daring imagination will hardly venture upon the suggestion that the power and the intelligence of man can ever arrest the procession of the great year.

Moreover, the cosmic nature born with us and, to a large extent, necessary for our maintenance, is the outcome of millions of years of severe training, and it would be folly to imagine that a few centuries will suffice to subdue its masterfulness to purely ethical ends. Ethical nature may count upon having to reckon

* "L'homme n'est qu'un roseau, le plus faible de la nature, mais c'est un roseau pensant. Il ne faut pas que l'univers entier s'arme pour l'écraser. Une vapeur, une goutte d'eau, suffit pour le tuer. Mais quand l'univers l'écraserait, l'homme serait encore plus noble que ce qui le tue, parce qu'il sait qu'il meurt; et l'avantage que l'univers a sur lui, l'univers n'en sait rien."—*Pensées de Pascal*, chap. ii, x. [Man is but a reed, weakest in Nature, but a reed which thinks. It needs not that the whole Universe should arm to crush him. But were the Universe to crush him, man would still be more noble than that which has slain him, because he knows that he dies, and that the Universe has the better of him. The Universe knows nothing of this.—*Bohn's translation.*]

with a tenacious and powerful enemy as long as the world lasts. But, on the other hand, I see no limit to the extent to which intelligence and will, guided by sound principles of investigation, and organized in common effort, may modify the conditions of existence, for a period longer than that now covered by history. And much may be done to change the nature of man himself. The intelligence which has converted the brother of the wolf into the faithful guardian of the flock ought to be able to do something toward curbing the instincts of savagery in civilized men.

But if we may permit ourselves a larger hope of abatement of the essential evil of the world than was possible to those who, in the infancy of exact knowledge, faced the problem of existence more than a score of centuries ago, I deem it an essential condition of the realization of that hope that we should cast aside the notion that the escape from pain and sorrow is the proper object of life.

We have long since emerged from the heroic childhood of our race, when good and evil could be met with the same "frolic welcome"; the attempts to escape from evil, whether Indian or Greek, have ended in flight from the battle-field; it remains to us to throw aside the youthful overconfidence and the no less youthful discouragement of nonage. We are grown men, and must play the man

"strong in will
To strive, to seek, to find, and not to yield,"

cherishing the good that falls in our way and bearing the evil, in and around us, with stout hearts set on diminishing it. So far, we all may strive in one faith toward one hope:

"It may be that the gulfs will wash us down,
It may be we shall touch the Happy Isles,

". . . but something ere the end,
Some work of noble note may yet be done." *

"Teach, and let the examination take care of itself," was the advice given by Mr. A. E. Hawkins, in his Notes on Science Teaching in the Public Schools, read in the British Association. In his experience he had found that a little knowledge went a long way in an examination. If necessary, the experiments of the lecture could be performed by one of the boys, the rest watching him; but it was better that all the boys should make experiments, preferably working in pairs.

* A great proportion of poetry is addressed by the young to the young; only the great masters of the art are capable of divining, or think it worth while to enter into, the feelings of retrospective age. The two great poets whom we have so lately lost, Tennyson and Browning, have done this, each in his own inimitable way; the one in the Ulysses, from which I have borrowed; the other in that wonderful fragment, Childe Roland to the dark Tower came.

EVOLUTIONARY ETHICS.

THE preceding article concludes Prof. Huxley's famous Romanes Address, the first part of which was given in The Popular Science Monthly for November. As bearing on the author's main contention that the ethical progress of society is opposed to the cosmic process of evolution, the following letter will be read with interest.—Ed.

To the Editor of The Popular Science Monthly:

Sir: He who crosses swords with Prof. Huxley in a dialectical encounter takes his life in both hands. I am not unaware, therefore, of my temerity in entering the lists against a scholar so fully equipped on all subjects; and my timidity is greatly increased when I venture to question his interpretation of the law of the "survival of the fittest," a subject upon which he is universally recognized as an authority. Yet it is because of what I deem to be a misinterpretation of that law that goes to the very marrow of a recent discussion by him that I venture to differ with him.

In his exceedingly thoughtful and suggestive Romanes Lecture on Evolution and Ethics, Prof. Huxley maintains that the cosmic process of evolution is directly opposed to the ethical development of mankind, "that the cosmic process has no sort of relation to moral ends" [see this number of the Monthly, p. 189], and that the struggle for existence and the survival of the fittest can never help man toward ethical perfection. "Social progress," he says, "means a checking of the cosmic process at every step, and the substitution for it of another, which may be called the ethical process; the end of which is not the survival of those who may happen to be the fittest, in respect of the whole of the conditions which exist, but of those who are ethically the best. As I have already urged, the practice of that which is ethically best—what we call goodness or virtue—involves a course of conduct which, in *all* [the Italics are mine] respects, is opposed to that which leads to success in the cosmic struggle for existence. In place of ruthless self-assertion it demands self-restraint; in place of thrusting aside, or treading down, all competitors, it requires that the individual shall not merely respect, but shall help his fellows; its influence is directed not so much to the survival of the fittest, as to the fitting of as many as possible to survive" [pp. 188, 189]. Holding these views it is to be expected that Prof. Huxley should describe man's development in the following words: "Man, the animal, in fact, has worked his way to the headship of the sentient world, and has become the superb animal

which he is, in virtue of his success in the struggle for existence. The conditions having been of a certain order, man's organization has adjusted itself to them better than that of his competitors in the cosmic strife. In the case of mankind the self-assertion, the unscrupulous seizing on all that can be grasped, the tenacious holding of all that can be kept, which constitute the essence of the struggle for existence, have answered" [November MONTHLY, pp. 21, 22].

Are the qualities here emphasized the only essential ones? Does this statement include all the facts or cover the whole truth? To me it seems to be far from doing this, although it states clearly and vigorously what all must admit to be partially true.

The benefits of co-operation in the development of man are too well recognized to be denied. Physically weaker than many of the animals that surrounded him, he could not long have survived in a struggle for existence against them had he been forced to continue that struggle alone. Nor could he have attained the mental development upon which so much of his success has depended without contact with his fellows. The most important if not the necessary condition of man's success in the struggle for existence is society. Social growth becomes possible only through the survival of the *socially fit*. In an advancing society this process must ever tend toward the production and preservation of the "ethically best." Recognition of the rights of others has been equally as important in the evolution of man as self-assertion. Indeed, it may be claimed that, under the conditions of social life, it is a necessary consequence of self-assertion. Men could not live long together unless they recognized the right of each to his own, and respected it. The survival of a society, like the survival of the individuals composing it, becomes possible only through adaptation to the *necessary* conditions of life, and it will not be denied by Prof. Huxley that morality is essential to social well-being. Indeed, he admits as much, for he says: "One of the oldest and most important elements in such systems is the conception of justice. Society is impossible unless those who are associated agree to observe certain rules of conduct toward one another; its stability depends on the steadiness with which they abide by that agreement; and so far as they waver, that mutual trust which is the bond of society is weakened or destroyed" [November MONTHLY, p. 24].

I am somewhat at a loss to reconcile this statement with the general teaching of the lecture. It seems to me that this moral development is just as much a part of the "cosmic process" as physical or mental development, neither of which are excluded by Prof. Huxley. Moral development comes, to be sure, in recognizable quantities, rather later in history than the others, and is of

greater consequence in a high civilization than in a low; is, indeed, or ought to be, considered one of the principal signs of the existence of the former. While it was essential in even the lowset form of social organization, it was for a long period of less apparent importance. The earlier struggles for existence were chiefly intertribal or international, and in these the qualities emphasized by Prof. Huxley as necessary for success were undoubtedly predominant. While the struggle still goes on in this form, it no longer occupies the time and attention of mankind to the same extent as formerly. Among civilized societies at least the struggle for existence has also taken on another form, and the conditions of success have greatly changed. Industrial competition has taken the place of war, and notwithstanding that the theories and the methods of international conflict are still somewhat potent in this field, they are so mostly because our ethical, and, for that matter, even our intellectual, training has not gone far enough. It can not be denied that the reign of industrialism, or at least the absence of war, has softened the manners if it has not changed the character of men. Prof. Huxley himself bears witness to this, for he says, "The cosmic nature born with us and, to a large extent, necessary for our maintenance, is the outcome of millions of years of severe training, and it would be folly to imagine that a few centuries will suffice to subdue its masterfulness to purely ethical ends" [p. 190].

It can, however, be shown, I think, that those societies will become the victors in the struggle for industrial supremacy, who are mentally and morally the most highly developed, or, in other words, socially the fittest. In an article on Ethics and Economics, published in The Popular Science Monthly for October, 1888, I have discussed this proposition at some length, but the following quotation will, I think, answer my present purpose:

"For the purpose in hand, we desire to call attention to the necessity of basing our political economy on moral rather than on selfish instincts. Powerful though the latter be, they are more or less anti-social in their nature, and therefore would not of themselves favor economic growth. That depends for its development on social growth, and it is only when the selfish instincts are held in due check and subordination to the higher impulses that the latter is possible. Strength, keenness, and shrewdness are important factors in determining the survival of the individual, and, in so far as they do this, they favor also the survival of the race. But of more importance still are those traits which, by enabling men to live together in peace, render possible the organization of labor in such manner as to secure the greatest economic return. In a word, our political economy, which has been unmoral, must be made moral, if it is to be the science

which shall direct men into the proper paths for the production and distribution of wealth" (pp. 773, 774).

If this be true, then even under existing conditions it may be said that "the stars in their courses" fight for righteousness. For it would appear that co-operation, which has been so essential to man's success in the struggle for existence, by cultivating the moral qualities upon which social fitness depends, has at length brought about conditions where moralization becomes a prime factor in the success and survival of society. At all events it can, I think, be maintained that the law of the survival of the fittest admits of another interpretation than that put upon it by Prof. Huxley. It is not of necessity, as he thinks, opposed to the ethical progress of the race, but under it and because of it men become better through the survival of the socially fit.

ROBERT MATHEWS.

ROCHESTER, N. Y., *June 29, 1893.*

THE CREATION.

A PENOBSCOT INDIAN MYTH TOLD BY ONE OF THE TRIBE TO ABBY L. ALGER.

IN the beginning God made Adam out of the earth, but he did not make Glūs-kābé (the Indian God). Glūs-kābé made himself out of the dirt that was kicked up in the creation of Adam. He rose and walked about, but he could not speak until the Lord opened his lips.

God made the earth and the sea, and then he took counsel with Glūs-kābé concerning them. He asked him if it would be better to have the rivers run up on one side of the earth and down on the other, but Glūs-kābé said, "No, they must all run down one way."

Then the Lord asked him about the ocean, whether it would do to have it always lie still. Glūs-kābé told him, "No!" It must rise and fall, or else it would grow thick and stagnant.

"How about fire?" asked the Lord; "can it burn all the time and nobody put it out?"

Glūs-kābé said: "That would not do, for if anybody got burned and fire could not be put out, they would die; but if it could be put out, then the burn would get well."

So he answered all the Lord's questions.

After this Glūs-kābé was out on the ocean one day and the wind blew so hard he could not manage his canoe. He had to go back to land, and he asked his old grandmother (among Indians this title is often only a mark of respect and does not always in-

dicate any blood relationship), Māhli Moninkwess (the woodchuck), what he could do. She told him to follow a certain road up a mountain. There he found an old man sitting on a rock flapping his wings (arms) violently. This was Wūchowsen, the great wind-blower. He begged Glūs-kābé to take him up higher where he would have space to flap his wings still harder. So Glūs-kābé lifted him up and carried him a long way. When they were over a great lake he let Wūchowsen drop into the water. In falling he broke his wings and lay there helpless.

Glūs-kābé went back to sea and found the ocean as smooth as glass. He enjoyed himself greatly for many days, paddling about, but finally the water grew stagnant and thick, and a great smell arose. The fish died and Glūs-kābé could bear it no longer.

Again he consulted his grandmother and she told him that he must set Wūchowsen free. So he once more bore Wūchowsen back to his mountain, first making him promise not to flap his wings so constantly, but only now and then, so that the Indians might go out in their canoes. Upon his consent to do this, Glūs-kābé mended his broken wings, but they were never quite so strong as at first, and thus we do not now have such terrible winds as in the olden days.

This story was told to me by an old man whom I had always thought dull and almost in his dotage; but one day, after I had told him some Indian legends, his whole face changed, he threw back his head, closed his eyes, and without the slightest warning or preliminary began to relate, almost to chant, this myth in a most extraordinary way, which so startled me that I could not at the time take any notes of it, and was obliged to have it repeated later. The account of Wūchowsen was added to show the wisdom of Glūs-kābé's advice in the earlier part of the tale, and is found among many tribes.

STATE INTERFERENCE IN SOCIAL AFFAIRS.*

By JOSEPH SHIELD NICHOLSON, D. Sc.,
PROFESSOR OF POLITICAL ECONOMY IN THE UNIVERSITY OF EDINBURGH.

WE are confronted with the limited power of the state and the infinite variety of individual enterprise. To the older economists the difference seemed so great that they considered the presumption against state interference to be established. The rule, it is true, was never absolute and unqualified. Adam Smith

* From the presidential address before the Section of Economic Science and Statistics of the British Association for the Advancement of Science, at the Nottingham meeting, September, 1893 (London Times Report).

himself indicated some of the most important of these exceptions, and the list has been extended by his successors. But these exceptions were all based upon reasoned principles, such as the incapacity of the persons concerned, e. g., children to make fair contracts; the lack of individual interest in public works, e. g., the maintenance of roads, and the importance of the highest security, as in the regulation of the issues of bank notes. And in spite of all these exceptions—strengthened and purified by these exceptions—the presumption remained undisturbed. Recently, however, some writers, under the influence of the ideal of *maximum* happiness and impressed by the power of the state, have sought to extend its interference far beyond these admitted principles- But, so far as this movement has any theoretical support, the reaction has already begun. The fundamental importance of freedom of contract has become more apparent than ever through the application of the comparative and historical methods to jurisprudence; the proposition that the progress of society has been from *status* to contract has almost acquired the force of an axiom. The analysis, too, of modern industrial systems in which division of labor has become more and more intricate and interdependent has shown the hopelessness of the attempt to transfer the management and control to the state. Changes in the methods of production, in the diffusion of knowledge, and in the transport of material commodities have been so rapid and so great that no executive government could have overtaken them. In the most advanced communities even that legislation which is necessary for the new conditions lags behind; even those elementary forms which simply aim at giving an interpretation to contracts in doubtful cases, or which are necessary for the adjustment of responsibility (as in bankruptcy and partnership), are behind the times. The growth of joint-stock enterprises has outstripped the development of the law of companies, and there is a crop of new frauds without corresponding penalties. Turning to the executive and administrative functions of government, the analysis of existing conditions shows that we have not yet overtaken those exceptions admitted by the strongest supporters of *laisser faire*. The British Government has, it is true, wasted its energies in devising temporary expedients of various kinds, but it has not yet accomplished the programme of Adam Smith. Not only are there privileges and restrictions that ought to have been abolished long ago, but on the positive side the programme is not complete. We have just begun universal education on the lines laid down by Adam Smith, but his scheme for imperial federation is not yet within the range of practical politics. We have effected great financial reforms, but we still fall far short of the full development of his principles. Even in matters of currency

and banking—in relation to which the function of the state has always been recognized—we are lamentably in need of reform. But if the state can not overtake those duties which are so necessary and persistent that they were forced on the attention of the strongest supporters of *laisser faire,* how can we possibly justify the assumption of new functions which rest upon no better principle than the vague idea that the state ought to do something? Not only theoretically but practically signs of a reaction in favor of the old position are rapidly increasing. The experiments already made at playing the *rôle* of omnipotence and omniscience, against which governments were so emphatically warned by Adam Smith, have begun to bring forth thorns instead of figs. A government which lends its power and assistance to one set of people must be prepared to act in a similar manner in all similar cases. If once this principle is abandoned, governmental action becomes either a matter of chance or depends upon clamor and jobbery. It is wonderful how quickly the human mind discovers analogies in grievances, and how soon one cry leads to another. How can we justify the use of state credit for the purchase of lands in Ireland and fishing boats in Scotland if we are not prepared to give similar aid to the poor of England who are similarly situated? If we grant judicial rents in the country, why not in the towns, and if we fix by law one set of prices why not all prices? We must not be content with looking at the immediate effects of legislation; we must consider also the secondary and more remote consequences. The British Government is beginning to find that the camel is getting too far into the tent. The admission of a single ear is nothing to the admission of the hump and the knees and the rest of the beast. Now the ear may be interpreted to mean the grant of a few thousand pounds to Scottish fishers, the hump is universal old-age pensions at a cost of some fifteen or twenty millions a year, and for the knees you may take the nationalization of land at a cost of some two thousand millions, and for the whole beast you have the complete socialist programme. The conclusion that when the beast was in the Arab was out needs no interpretation. We have not yet reached the limits of tolerable taxation, but at the present rate of growth of imperial and local expenditure we are rapidly approaching those limits. It has been firmly established in theory, and confirmed by the experience of many nations, that excessive taxation is ruinous to a country. It may be replied that those who demand a large increase of expenditure for public purposes do not propose to tax the poor, but only to take the superfluities of the rich—to take, as is sometimes said, twenty shillings in the pound from that part of every income which extends above four hundred pounds a year. The certain effect of this kind of taxation would be that in a very

short time nobody would have more than four hundred pounds a year, and the sources of taxation would dry up just as people had become used to and dependent on governmental assistance. [Laughter.] The general argument may be summarized in the favorite phraseology of the day. The utility of every increment of governmental work rapidly diminishes, and the disutility of every increment of taxation rapidly increases. The classical economists maintain that even if the state could do something for individuals as cheaply and effectively as they could do it for themselves, it is in general better to trust to individual effort. The decisive consideration is the effect on the character and energies of the people. Self-reliance, independence, liberty—these were the old watchwords—not state reliance, dependence, and obedience. In the matter of pauperism, for example, they teach us to distinguish between the immediate effects of relief which may be beneficial and the effects of reliance on that relief which may be disastrous. They are bold enough to maintain that the condition of life of the dependent pauper should not be made by aids and allowances better than that of the independent laborer. They insist on the great historical distinction between the sturdy rogues and vagabonds—who can work and will not—and the impotent poor, the poor in very deed, who can not support themselves. They look upon the payment of poor rates as they look upon other forms of taxation—namely, as the lesser of two evils; they do not try to persuade themselves and other people that it is a duty which is essentially pleasant. If Christian charity realized a tithe of its ideal there would be no need for relief on the part of the state. It does not take ten ants to relieve another ant, and in this land of ours there are more than ten professed Christians to every pauper. To the student I would say, political economy has a vast literature, and you will not find all the good concentrated in the last marginal increment; you must master the old before you can appreciate the new; a portion of truth just rediscovered for the hundredth time by some amateur is not of such value as a body of doctrines that have been developed for more than a century by economists of repute. And to the legislator I would say, vaster than the literature of political economy is the economic experience of nations; the lessons to be learned from the multitudinous experiments of the past can never become antiquated, for they have revealed certain broad features of human character that you can no more disregard than the vital functions of the human body. Just as Harvey did not invent but discovered the circulation of the blood, so Adam Smith did not invent but discovered the system of natural liberty. And nothing has been better established than the position that legislation which neglects to take account of the liberties of individuals

is foredoomed to failure. If they can not break through the law they will get behind the law. The first duty of the legislator is to take account of the natural forces with which he must contend, and the classical economists have made a survey and estimate of these forces which, based as it is on the facts of human nature and the experience of nations, it would be willful folly to overlook.

THE FRUIT INDUSTRY IN CALIFORNIA.

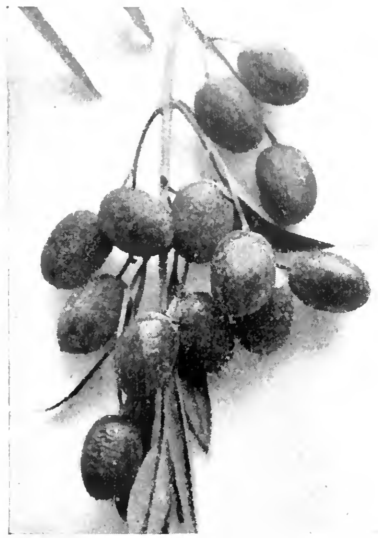
By CHARLES HOWARD SHINN.

IT seems to me that an account of the present condition of the fruit industry in California would be of economic value, provided that it were entirely free from the advertising element. By the "advertising element" I mean that very natural and almost irrepressible desire of a resident of any portion of this magnificent country to attract others to his particular district. There ought to be some way of presenting statistical and other facts relating to one department of horticulture in a given American State, in exactly the same spirit that an expert upon cotton manufacture would arrange the statistics of the mills of Massachusetts.

A considerable area of California lands is planted to orchards and vineyards. Some of these, as with other human enterprises, are profitable, and some are unprofitable; but all are producing fruit, most of which finds its way in some shape to markets outside the State. The range of these fruit products is very great, and many American producers, as well as those of Europe and other parts of the world, feel the competition of this food supply. An immense number of consumers, as well as this army of rival producers, must wish to obtain statistics of the California industry under consideration. The following article is an attempt to present the facts of a great fruit-growing industry so plainly that all its departments can be understood by the reader.

First, let us examine the best available statistics of the area planted, and the kinds of fruit used. These are much more complete now than when the officers of the last national census attempted to collect them from county officials, because competent agents of the State Board of Horticulture, themselves fruit-growers, spent the greater part of last year in making a "house-to-house canvass." They asked every man who owned an orchard to write down the number of acres he had in fruit trees, and classified the result, in many cases, by actual inspection of the orchard. The mass of details is of course too ponderous to be printed here, but the results can be analyzed so as to justify presentation in a series of tables. There are several ways of pos-

sible classification, but I can think of nothing better than to take the principal fruit-growing counties, give their areas and the acreage now planted, arranging the fruits reported upon in four divisions—the citrus and semitropic species, the nut-bearing trees, the ordinary deciduous fruits, and lastly the vines and small fruits.



Cluster of Uvaria Olives.
(One half natural diameter.)

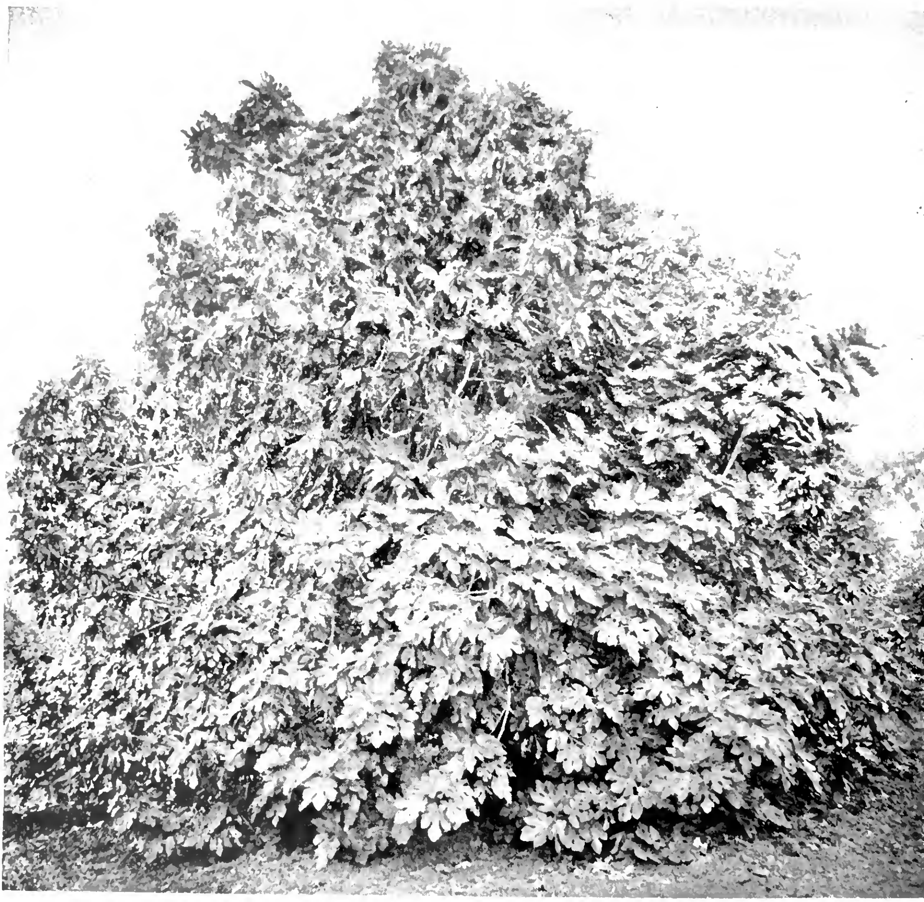
The principal citrus and semitropic fruits grown in California are the fig, olive, lemon, and orange. The citron of commerce flourishes, but has not been much planted, and the lime does well in some districts. The pomegranate is in many gardens, but few commercial orchards exist, and the same is true of the loquat and guava. Here and there in sheltered, frostless places are the beginnings of some small plantations of pineapples, bananas, and date palms, and a few specimens of cherimoya, granadilla, alligator pear, jujube, melon shrub, chayota, the best species of opuntia, and other tropic and semitropic fruits that are being tested on a very small scale. Easily first, and type of the whole class, is the orange. It is commercially grown to the extent of a hundred acres or more in fifteen counties of California; eight counties contain over five hundred acres apiece. The acreage of the new county of Riverside, created by the last Legislature, is necessarily included in San Bernardino, and that of Kings County in Tulare.

Table I.—*Acreage of Semitropic Fruits.*

County.	Oranges.	Olives.	Lemons.	Figs.
Butte	2,664	755	50	259
Los Angeles	12,297	788	2,000	973
Orange	5,412	270	681	82
San Bernardino	38,237	1,200	2,003	362
San Diego	1,500	1,063	4,790	291
Santa Barbara	540	871	1,276	950
Tulare	604	320	63	182
Ventura	548	613	443	62
Total (8 counties)	61,802	5,880	11,306	3,161

The forty-five remaining counties of the State contain acreages as follows: Oranges, 1,559; olives, 3,394; lemons, 1,090; figs, 2,119.

Adding these totals, we obtain the area of the semitropic orchards of California, according to the latest and most reliable data. There are 64,361 acres of oranges, 9,274 acres of olives, 12,396 acres of lemons, and 5,280 acres of figs. The entire acreage devoted to the semitropic fruits above classified is 91,311. No reasonable allowance for small orchards overlooked would be likely to bring this total to much more than 95,000 acres. Studying the table, we



Young Fig Tree. Tejon Ranch.

observe that the leading orange-growing counties are San Bernardino and Los Angeles; the leading fig county is Los Angeles, with Santa Barbara very close, but both still under the thousand-acre mark; the leading olive counties are San Diego and Santa Barbara, and the leading lemon counties are San Diego and Los Angeles. Placer, Butte, Sacramento, and Yuba are the only counties in the Sacramento Valley and northern Sierra foothills that

have a hundred acres of oranges; Fresno, Stanislaus, and Tulare, in the San Joaquin Valley, have also barely commenced the culture of semitropic fruits. But the industry is more at home in the Coast Range valleys from Santa Barbara south and southeast. There, also, it is of longer growth, three out of four trees being in bearing, while in the counties that have but lately begun to plant semitropic fruits more than half the orchards have not yet fruited to any extent. The beginnings of fig and olive orchards are more generally distributed throughout the State than are lemon and orange orchards. Classified from this standpoint, the lemon is represented by one or more acres in thirty counties, the orange in thirty-eight, the fig in forty-two, and the olive in forty-four.

Deciduous fruits cover a very wide range, both in variety and distribution. The apple, apricot, cherry, peach, prune, and pear are the principal deciduous fruits grown in California. There are some nectarine and quince orchards, and the Japanese persimmon is planted to some extent. Many other deciduous fruit trees find place in family orchards and experimental grounds, but those named comprise all that are of commercial value at the present time.

A complete table of the deciduous fruit acreage by counties would include every one of the fifty-three. The apple, for instance, is grown everywhere. The peach and prune better represent the deciduous fruits. A unit of one hundred acres would force us to classify some forty-five counties. Even five hundred acres as a unit would list twenty-nine counties; but, by raising it to a thousand acres, we include all, or nearly all, of the famous deciduous fruit districts.

TABLE II.—*Acreage of Deciduous Fruits.*

COUNTY.	Apples.	Apricots.	Cherries.	Peaches.	Pears.	Prunes and plums.
Alameda	505	3,310	2,171	1,375	1,701	4,236
Butte	307	540	165	3,286	913	1,144
El Dorado	225	29	39	1,338	200	279
Fresno	185	556	7	2,058	634	1,601
Kern	338	320	25	1,079	315	946
Los Angeles	1,511	2,899	18	4,059	1,661	3,748
Orange	128	1,492	10	1,203	900	905
Placer	332	280	272	3,621	1,070	615
Sacramento	139	535	160	2,870	2,900	1,770
San Bernardino	222	1,554	15	2,090	402	1,463
Santa Clara	750	4,350	1,250	5,570	900	8,900
Solano	153	3,733	436	4,915	3,050	2,870
Sonoma	4,121	229	317	2,507	1,407	2,600
Tehama	86	574	100	3,182	520	1,328
Tulare	147	724	10	3,800	642	5,270
Yolo	75	824	50	1,040	621	1,522
Total (16 counties)	9,224	21,949	5,045	43,993	17,836	39,197

Drying the Apricots.

The remaining thirty-seven counties of the State contain acreages as follows: Apples, 10,753; apricots, 8,176; cherries, 1,883; peaches, 11,007; pears, 5,906; prunes and plums, 15,445. Adding these totals, we obtain the area of the deciduous orchards. There are 19,977 acres of apples, 30,125 acres of apricots, 6,928 acres of cherries, 55,000 acres of peaches, 23,742 acres of pears, and 54,642 acres of prunes and plums.

The deciduous fruits lead in acreage and value of products all other branches of California horticulture; and as the above table

ALMOND TREE IN FEBRUARY. Rancho Chico.

plainly shows, the same concentration of each separate variety of fruit in some particular district is manifest everywhere. There are apple counties, peach counties, prune counties, and always will be, although some changes will take place in a decade or two. Peaches, prunes, and apricots occupy nearly three fourths of the acreage. The cherry orchards, although covering the smallest

area, are more profitable, and give employment to more laborers, in proportion to acreage, than any others of the class. The greater part of the apple crop is consumed at home, but all the other fruits must find their chief market outside the State.

In addition to the acreage already tabulated, there are 1,080 acres of nectarines, 300 acres of quinces, and about 100 acres of Japan persimmons. This makes a grand total of 191,894 acres devoted to this class of fruits. Statistics are somewhat incomplete for some of the mountain counties, but it will not be safe to add more than five per cent, and we can then say in round numbers that 200,000 acres are planted with the deciduous fruits.

The leading apple counties of the State are Sonoma, Los Angeles, Siskiyou, Santa Cruz, San Diego, and Humboldt. Nothing could better illustrate the extent to which the climate of California is modified by local conditions. San Diego is the most southern county, Siskiyou is the most northern, and they are separated from each other by more than seven hundred miles, but both contain great apple-growing districts. The leading apricot counties are Solano, Alameda, and Los Angeles. The cherry is chiefly grown in Alameda and Santa Clara. The peach industry has been most completely developed in Santa Clara, Solano, Los Angeles, Tulare, Butte, and Tehama. Nectarines are mostly planted in Sonoma and Alameda. Plums and prunes seem to belong chiefly to Santa Clara, Tulare, Alameda, and Solano. Lastly, the great pear districts are in Sacramento, Solano, Alameda, and Los Angeles. The Coast Range lowlands and foothills, together with a few districts in the San Joaquin and Sacramento Valleys, produce the bulk of all the deciduous fruits.

Third among the horticultural divisions that I have thought it desirable to tabulate are the nut-bearing trees, comparatively small in present acreage, but likely to become more and more important industries. The nuts grown on a commercial scale are only two, the almond and the walnut. The chestnut, pistachio, filbert, pecan, and a few others have been planted to some extent. The following table shows the counties that have 1,000 acres and upward of either almonds or walnuts:

Table III.—*Acreage of Nut-bearing Trees.*

County.	Almonds.	Walnuts.
Alameda	1,237	36
Butte	1,588	12
Los Angeles	107	1,789
Orange	102	2,592
Santa Barbara	340	1,203
Solano	1,470	70
Ventura	150	6,310
Total (7 counties)	4,984	11,022

The remaining forty-nine counties only bring the total of almond trees in the State to 9,400 acres and that of walnuts to 14,912 acres. One can easily see how limited are the districts as yet devoted to these products. Three almond counties—Butte, Solano, and Alameda—contain nearly one half of the total acreage of the State; four walnut counties—Ventura, Orange, Los Angeles, and Santa Barbara—contain more than four fifths of all the trees planted. The almond, however, is grown to some extent in forty-six counties and the walnut in forty-five. Italian chestnuts, pecans, and filberts have been planted to the extent of perhaps 100 acres. This makes the total acreage of nut-bearing trees in the State 24,412. It is not likely that more than 100 or 200 acres were overlooked. In round numbers there may possibly be 25,000 acres in this class of trees.

The last division contains the grapes and small fruits. Wine and raisin grapes have been very carefully tabulated each year, but table grapes with less attention to details, and small fruits not at all until recently. The grape industry is mostly carried on in the fourteen counties represented by the following table:

TABLE IV.—*Acreage of Grapes.*

County.	Wine grapes.	Raisin grapes.	Table grapes.
Alameda	6,396	194	236
Fresno	5,474	43,928	100
Los Angeles	4,632	671	1,182
Napa	18,177	10	52
Placer	354	500	1,421
Sacramento	3,131	385	2,550
San Bernardino	1,024	2,591	274
San Diego	132	4,455	510
Santa Clara	10,294	200	1,200
Santa Cruz	1,365	103	1,253
Solano	1,928	1,328	1,167
Sonoma	22,351	.....	427
Tulare	70	10,264	100
Yolo	1,575	5,500	1,500
Total (14 counties)	76,903	70,077	11,972

The total acreage of wine grapes is 91,428; that of raisin grapes is 81,773; and that of table grapes is 18,732. Besides, the area devoted to small fruits, as far as can be ascertained, is 5,081 acres. Alameda, Sacramento, and San Joaquin contain over three fifths of the small-fruit area of the State.

Returning to grapes, the results are obtained from the statistics of the State Viticultural Commissioners' Report of 1891, with the figures for a few missing counties filled in from other reliable sources. As in previous tables, the chief centers of each department of the industry are easily recognized. Table grapes are of

especial importance in Sacramento, Yolo, Placer, Santa Cruz, Santa Clara, Solano, and Los Angeles, in which counties more than half the table grapes are found. Two counties of the San Joaquin Valley, Fresno and Tulare, have planted five eighths of the total raisin-grape area of the State. Three wine counties—Sonoma, Napa, and Santa Clara—contain five ninths of the total wine-grape area.

In round numbers, then, the fruit and vine acreage of California in October, 1893, is as follows:

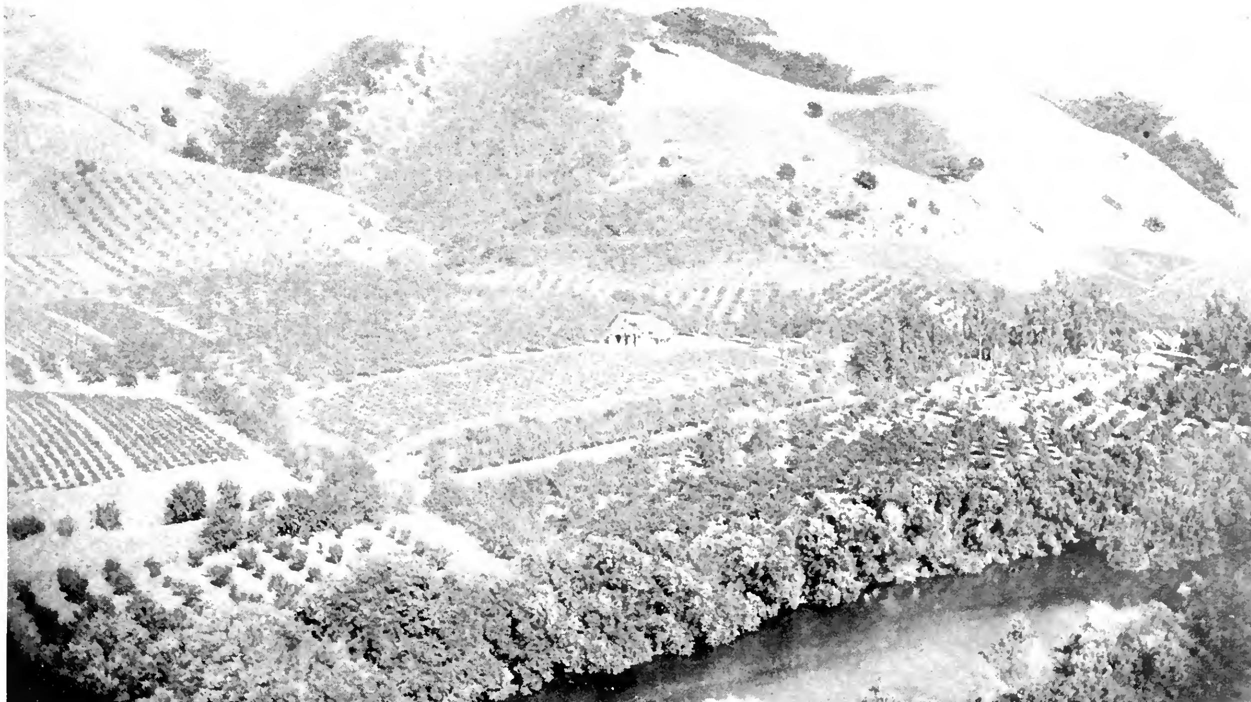
Citrus and semitropic	95,000
Deciduous fruits	200,000
Nut-bearing trees	25,000
Grapes	191,933
Small fruits	5,081
Total	517,014

Having ascertained the total acreage, the approximate number of fruit-bearing plants of the kinds tabulated can be readily found. Orchardists set trees at different distances apart according to the soil and the variety: $12' \times 12'$, $15' \times 15'$, $18' \times 18'$, and $20' \times 20'$ can be found within a mile of each other. Walnuts and other strong growing trees are often set $30' \times 30'$, with cultivated crops planted between for a few years. The above systems of planting give respectively the following number of trees to the acre: 302, 193, 134, 108, and 48. Of course, there are many other planting distances in general use. The ordinary rule of multiplying the acreage by 100 has never seemed to me sufficiently accurate, and I should choose 150 as more nearly representative of the orchards of to-day. Grapevines are planted $4' \times 6'$ in the case of some varieties, and $4' \times 8'$, $6' \times 6'$, and $8' \times 8'$ in ordinary vineyards. These distances give the following numbers of plants to the acre: 1,815, 1,361, 1,210, and 680; about 1,200 is probably a fair average.

Tabulated, with a fair allowance for the acreage planted in the spring of 1893, the sum of the whole matter is as follows:

Number of trees on 320,000 acres	48,000,000
Number of vines, etc., on 200,000 acres	240,000,000
Trees and vines of the plant of 1893 (about)	7,500,000
Total number of plants (about)	295,500,000

The reader must remember that every one of these plants, excepting vines grown from cuttings, has been propagated in a nursery, set out by hand with more or less carefulness, and pruned and cultivated. About sixty per cent of the fruit trees are now in partial or full bearing; in the vineyards the proportion is probably somewhat greater.



Hillside Vines and Trees. Niles Cañon.

What is the gross yield from these trees? Like wheat, or any other staple crop, the average per acre is very much less than one would expect.

There are often such heavy losses from late frosts, drought, insect pests, and fungoid diseases that only a person of more than ordinary intelligence can successfully manage large orchard interests. The average orchard, like the average farm, just about makes a fair living for an industrious man. That this is true can be easily shown by the following figures, and deductions from them:

Orchard and Vineyard Products in 1891.

Class.	Pounds.
Canned fruit	64,790,120
Dried fruit	66,743,134
Fresh, deciduous	101,097,940
Prunes	10,220,700
Raisins	45,558,370
Citrus fruits	88,194,560
Figs	50,000
Nuts	10,318,060
Total shipment, in pounds	386,972,884

It requires not less than 600,000,000 pounds of fresh fruits, besides the nuts, to produce the above results. In round figures, then, 600,000,000 pounds represent the fruit surplus of the State, in the departments of deciduous fruits, citrus fruits, raisins, and table grapes. In addition there was a surplus of

Wine (gallons)	11,114,029
Brandy (gallons)	799,614
Olive oil (cases)	12,088

Now, there are in California about 500,000 acres of the trees and vines which produce these 600,000,000 pounds of fresh fruit. That is 1,200 pounds to the acre, worth in the orchard from twelve to forty dollars, the average gross value of the crop from an acre of fruit. Of course, many of the trees are not yet in bearing, and some fruit-growers will always have far better returns than this. But the above average is very significant. It shows plainly that the industry can not exist upon a lower average price than one cent a pound for fruit in the orchard. But if the present orchards were in full bearing there might come an especially favorable season which would give a total, even without further planting, of fully 1,500,000,000 pounds. If there are 50,000 acres planted every year, and the old orchards are kept up, the present acreage will be doubled by 1901.

But, to show what has been done under favorable circumstances, I give the following statement of the yield of a 700-acre San Joaquin Valley irrigated orchard in 1890:

Yield of 700-Acre Orchard.

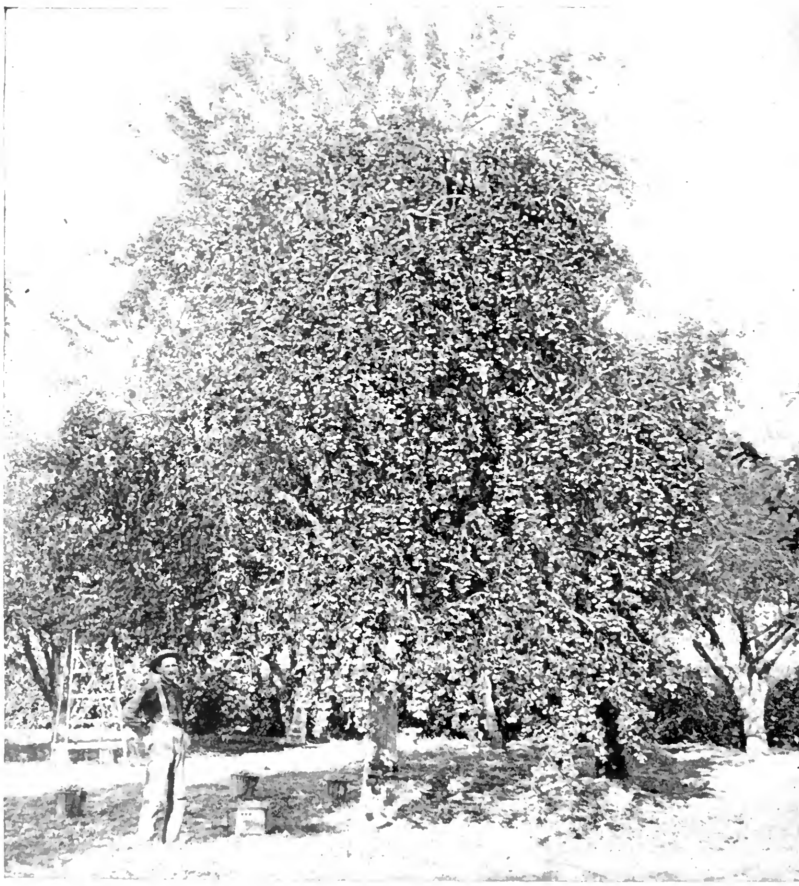
	Pounds.
Apricots	339,411
Peaches	2,115,314
Nectarines	210,518
Pears	280,124
Plums	4,705
Prunes	22,283
Total	2,972,335

This is a well-authenticated yield of nearly 3,000,000 pounds from the orchard, or, to be more exact, within a fraction of 4,246 pounds to the acre. This fruit was sold for $84,365.61, or $120 per acre, gross receipts. The annual product of the 1,200 acres of vines and trees upon this ranch is confidently expected to be 10,000,000 pounds of fresh fruit when every acre comes into bearing, and that is practicable under first-class management. Ignorance or neglect would ruin both orchard and vineyard, however, in less than three years. The average yield per acre, as previously shown, is only 1,200 pounds, but here is a tract of 700 acres, not in full bearing, that gives three and a half times as much. By obtaining the highest possible price, the estimated possible sale of about $45 per acre (when the yield was 1,500 pounds) has been raised in this case to $120 per acre. Should the whole 1,200 acres ultimately yield 10,000,000 pounds, the average per acre will be more than four tons of green fruit, the increase being largely in the item of grapes. Four tons per acre, at a uniform price of one cent a pound, would yield $80, as against the average value of the State crop at that price, $12 per acre.

If the 200,000 acres of deciduous fruits in the State could be made to yield at the rate of this irrigated San Joaquin Valley orchard, the product would now be about 850,000,000 pounds of fresh fruit. The same acreage in full bearing at the expected average would reach the enormous yield of 1,660,000,000 pounds. If the semitropic fruits and vineyards could be depended upon to yield in like proportion, it is safe to say that the fruit supply of the world would be more than provided for, and the transportation facilities of the great railroad lines would be overburdened. But horticulture, like agriculture, is subject to drawbacks and limitations. Orchards and vineyards, exactly the same as corn fields and wheat fields, give only a low general average. The industry of fruit-growing is established upon a solid foundation and is very prosperous, but the whole yield of the State can never be made proportionate to the yield obtained under exceptional circumstances.

The acreage and yield of the orchards and vineyards have now been ascertained. The cash value of the total output can not be

as closely calculated. Floating estimates vary even more than the floating estimates of the acreage. Healthy, well-managed orchards probably average gross sales of $100 per acre, taking all classes of fruit together, and one season with another, but there are no reliable statistics of this side of the industry. Returning to an estimate of a present surplus of 600,000,000 pounds of fresh fruit, this at two cents (the average value in the orchards one year



Vacaville Pear Tree.

with another) would yield the growers $12,000,000 and would probably cost the consumer $36,000,000. This does not include the value of the product of the wine grapes. It only represents the output of the gold mine of the orchards. Commercially, of course, the volume of business created is represented by the cost to the consumer.

Studies of the future of an industry are seldom useful. Planting of trees and vines continues steadily, and if there is a demand

the present output can be indefinitely increased. It is believed by the best horticultural authorities that fruit, in various forms, will become more and more a great food staple, used by the masses of the people, and that new markets for the enormous output can be developed from time to time in the United States and in Europe. Like wheat, a staple, fruit in the future will not make fortunes nor "pay for a ranch in one year," but will give safe, steady returns upon the labor and capital invested.

The extensive area that might be devoted to fruit culture, if the demand justified such a use, can be seen by the following figures: San Bernardino, Riverside, San Diego, and Los Angeles Counties, all noted for their semitropic fruits, contain 26,913,000 acres, or in round numbers one fourth the area of the State. Fresno, Kern, and Tulare, the great irrigated counties of the San Joaquin Valley, famous for their vineyards and deciduous fruit orchards, contain 14,737,000 acres. The rich and beautiful fruit counties of Alameda, Butte, Placer, Sacramento, Santa Clara, Solano, Sonoma, and Ventura, added to the above, bring the total area to nearly 50,000,000 acres. It need not be supposed that all these immense districts can be cultivated. There are deserts and barren mountains, as well as fertile valleys, plains, and hillsides. But if only one third of the area of these counties is capable of being cultivated, and if only one third of the cultivated acreage is used for fruits, these counties alone can produce, when their orchards are in full bearing, twenty times as much fruit as the present entire yield of the State. The future of the fruit industry of California depends upon the growth of the demand for fruit products. All the other conditions are favorable for the development of the business, but the problem of the possible demand can only be solved by continuing to plant trees, gather fruit, and send it to the markets of the world.

The picturesque side of California fruit-growing is very attractive and must long remain so. Just now everything is in the creative stage: vineyards and orchards are being extended along the valleys and up the slopes; the cabins of pioneers are giving place to modern cottages and stately dwellings; villages are fast becoming towns; and towns are rising to the rank of cities. Only about the old missions can one find orchards that deserve to be called venerable, as measured by European standards. Take out a few old trees of olive, fig, orange, and pear, and all that is left are less than forty years old.

Blossoming springtime in these great orchards is charming, as almonds, apricots, peaches, and all the rest of the deciduous fruit trees come into flower over square miles. The very roadsides are sometimes covered with drifts of petals blown from the overhanging boughs. Loquats ripen and are fit to market almost

before the last apple blossoms are gone in the orchards; cherries come next, then the early apricots and plums; the procession goes on month after month, even after the leaves fall. Late apples, pears, and Japanese persimmons mark the California December, mingling as they do with the ripening oranges and lemons and a few figs hanging on the leafless trees.

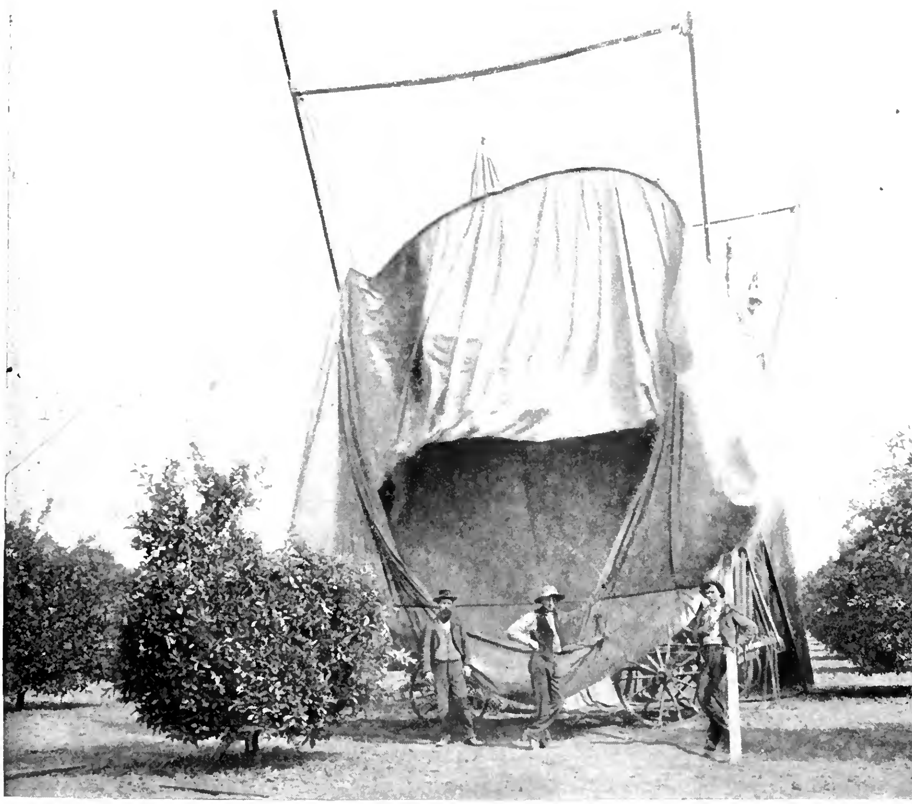
Although the details of the orchard work vary considerably in different parts of California, the more important elements are much the same everywhere. The winter work of pruning is succeeded by the spring work of cultivation and the summer work of harvest. A highly organized system has been developed; labor-saving machinery is used to a great and increasing extent; and the actual cost of producing a pound of fruit can be proved to have lessened every year. One hesitates to say how cheaply fruit can be grown under favorable circumstances by intelligent Americans who know the business. Men are becoming rich at prices that ten years ago would have seemed ruinous. Of course, there is a limit to the process of cheapening production, but the end is still far off. The planting and culture of orchards; the thinning of green fruit; the gathering, handling, packing, shipping, and marketing of ripe fruit; the canning, drying, preserving, and other methods of utilizing fruit products—all these are in a process of continuous evolution.

The foregoing glimpses of the subject indicate more than the beginnings of a great industry. Whoever visits California will see surprisingly vast and imposing results in concrete forms. Valley after valley, town after town live by the toil of the orchardist and vineyardist. The sight is a cheering one, because successful fruit culture requires a high degree of skill and intelligence, a thickly settled rural community, and especial facilities for communication with all that these things imply. The road-improvement societies are little needed in California fruit colonies. Sometimes the macadamized and sprinkled highways extend six or eight miles out of the town to the very edge of the orchards; then, as the wheat fields are reached, they degenerate into very ordinary country roads.

But the educational requirements of this specialized industry extend into new departments of science, and are continually developing so rapidly that only a few trained observers can take note of the advance. Horticulture, applied to the daily needs of such industries as I have described, leaves its servants no time to dream dreams about possibilities of orchard life a century or even a decade hence. Multitudes of perplexing problems of culture and management arise, but two great tasks are always with the educated orchardist or vineyardist. One, briefly stated, is, "Can I produce new and vastly superior varieties by cross-fertili-

zation and scientific study of the laws of heredity and variation applied to plants?" The answer is, "Yes; there is no assignable limit to the capacity of our cultivated fruits, and of fruits still wild, to improve and develop new characteristics."

The second great task relates to the ceaseless struggle with the lower forms of animal and vegetable life which prey upon useful forms in immeasurable and innumerable hosts. Gophers and jack-rabbits are now only pests of minor importance in thickly settled orchard-districts, but the warfare of the horticulturist



FUMIGATING TENT. Hydrocyanic-acid gas process for destroying scale. Chino Valley.

with fungoid diseases and parasitic insects long ago passed its amusing stage. It is a serious business of importance to the whole human race, because whatever threatens the food supply threatens the life of man. The practical applications of skill and capital in the field of preventive and remedial agencies have been remarkable. Every successful Californian fruit-grower has now learned that he must as regularly treat his trees for scale and other inflictions as he must plow his land, thin the fruit, or gather the crop. At the spraying season in the fruit districts

it is literally true that the odor of the various preparations used to destroy insect life is universal for miles and for days at a time. Nine tenths of the discussions in the innumerable local clubs of fruit-growers that are doing so much for the practical advance of the industry in California are discussions upon methods for the destruction of these pests. Sometimes one sees hundreds of acres of orchard, in February, snow-white over every inch of twig, with "salt and lime wash," or other acres are brown with sulphite of soda or oil and alkali. Now and then comes an orchard where the remedies have been used in too great strength, and the buds and tender bark seem blighted and blackened.

Almond Bough in July.

The prevailing enemy of the orchards is the insect family *Coccidæ*. The species that do most harm are the oyster-shell scale (*Mytilaspis pomorum*), the pernicious scale (*Aspidiotus perniciosus*), the yellow orange scale (*Aspidiotus citrinus*), the red orange scale (*Aonidia aurantii*), and the apricot scale (*Lecanium armeniacum*). The Florida red scale (*Aspidiotus ficus*) and the mining scale (*Chionaspis biclavis*), a very dangerous species from Tahiti, are being quarantined against by the horticultural commissioners. A cargo of 325,000 orange trees infested with the Tahiti species was once destroyed by Mr. Craw, the quarantine officer of the State Board. Another group of scale insects known as "cottony scales" (*Icerya* and *Dactylopius*) are among the worst enemies of the orchardist. Aphides, canker worms, caterpillars, and fungoid diseases are as yet of much less immediate danger to the fruit-growers than the various *Coccidæ* of which I have named only the prominent species.

Many valuable formulas for summer and winter washes, for kerosene emulsions, and other preparations were first used in California. The hydrocyanic-acid-gas method is also a Californian

invention. Derricks and tents are used in this gas treatment, and it solves many difficulties in the way of using washes and the spray system on the citrus fruit trees. The city of Riverside owns several complete sets of the necessary apparatus, and rents at a nominal rate to fruit-growers, who hire operators and furnish the necessary chemicals. Since this is not a technical treatise, however, I must refer students of the perpetual struggle going on in California between the orchardist and his insect enemies to the publications of the Agricultural Department of the State University and of the State Board of Horticulture. Here, in thousands of pages, the story is told in every detail. There is not only an active warfare going on against insect foes, but various predaceous and parasitic insects that destroy dangerous species have been called to the aid of the horticulturist.

In conclusion, one must ask, "How goes the fight?" The statistics of the fruit industry answer this question. The cost of destroying insect pests has become a permanent item of expense, the results of which are increased profits. Care and management of orchards now include preparation of the soil; selection of varieties adapted to the place; planting and culture of the trees; pruning, according to different systems for different species and localities; the use of special fertilizers, and the destruction of noxious insect life. The various coccids that infest the California orchard valleys are only to be found in dangerous numbers upon the orchards of the careless or the ignorant fruit-growers. Their multiplication is readily and safely checked on as large a scale as desired, and at a cost paid many times over by the increased crop. Sometimes, for several seasons and over large districts, the coccids disappear, but they return, and renewed expenditures of time and skill are necessary to conquer them again. The expense lessens, however, and the certainty of success increases, year after year as the fruit-grower becomes a specialist. Does this appear too difficult? It is the same old demand for intellect, inherent in the order of things. Horticulture in every division is a science as well as an art, and it more and more amply rewards the technical skill of the well-equipped specialist.

During the discussion in the British Association on anthropometric measurements, Dr. Garson expressed the opinion that there could be no better system than that adopted in the United States, where an enormous number of observations were made on a uniform plan in many schools. If the American plan could be adopted in Great Britain we should be able to compare children on both sides of the Atlantic, and have full details of the growth of the English race. The different methods of anthropometric observation now adopted rendered the results absolutely useless.

CRIMINAL WOMAN.

By Miss HELEN ZIMMERN.

THE school of criminal anthropologists is making great strides in Italy. New works are continually pouring from the press which record the observations of students of this modern science, all of them striving to establish the data on which to base the phenomena of crime and degeneration. The world-famed name of Prof. Cesare Lombroso constantly appears on new works, which are fresh guides to science. La Donna Delinquente (Criminal Woman) is the title of his latest book, which is a joint work written together with one of his pupils, Prof. G. Ferrero. This book completes his previous admirable study entitled L' Uomo Delinquente (Criminal Man). This new study on abnormal woman is a very important work, which offered much greater difficulties in the way of research and observation than that on man. Indeed, Lombroso writes in his preface: "The chief results of our first investigations were in opposition to the usual premises; even individual and partial observations seemed to clash; so that if one wished to be logical one was obliged to hesitate as to definite conclusions. We were, however, faithful to the maxim that we have always pursued; we followed facts blindly, even when they appeared to contradict each other and seemed taking a false turning. And we were not wrong: in the end the facts which seemed most opposed, fitted into their places like the pieces of a mosaic and formed a uniform and perfect design, although at first it seemed as if we were groping in the dark and that it was difficult to collect them. When at last we reached the desired goal, we tasted the bitter delight of the hunter who seizes his prey after scouring rocks and precipices, and feels the joy of his success redoubled by the losses and fatigues his conquest has cost him."

In this quotation is given truly the keynote to the whole volume. It explains to the reader what difficulties the authors have had to surmount, in order to draw a precise and certain conclusion, and to determine the characteristics of female criminals, just as other similar works written by modern *savants* define those of male offenders. The work is divided into four principal parts: 1. Normal Woman. 2. Female Crime. 3. Pathological and Anthropometrical Anatomy of Female Criminals and Prostitutes. 4. Biology and Psychology of Female Delinquents and Prostitutes. The first part is full of observations on normal women, and is a contrast to the second, which treats of female criminals in all their different changes of organism and mental attitude. In the section devoted to normal women, Lombroso

treats of the women of primitive nations and compares them with those of civilized peoples. The study is minute, subtle, and valuable. Nor does Lombroso hesitate even to make comparisons with female animals. This attitude, which might be called a want of respect, Lombroso explains in his preface, saying: "Those who, writing about women, are not content with the close logic of facts, but continue or rather counterfeit the traditions of the middle ages and use chivalry toward the gentle sex, will think that we have often been wanting in respect to them in our work. But if we have not respected our most cherished preconceived ideas, such as the idea of the '*reo nato*' (born criminal), neither have we been afraid of the apparent contradictions which to ordinary eyes might have seemed deleterious to our work. How could we become followers of a conventional and unscientific untruth, which only acquired shape in order to lose it directly?"

And truly science can not feed on rhetoric, and Lombroso's books are not those of a poet or novelist, but those of a scientific man, who believes in his work and who devotes himself seriously to its exigencies, no matter whither its necessary conclusions land him. In his study on criminal woman he brings before us women in every condition of life; he makes a minute study of their good qualities and of their defects, analyzing both, and only speaking when he can draw conclusions from what he has observed and studied. Hence his work is a powerful contribution to that affirmation of modern theories on crime which are destined to change entirely the theories of penal law which have ruled up to the present time.

The first portion of Lombroso's work is divided into chapters which treat of the females of the zoölogical world; of the anatomy and biology of women; of the senses and mind of women; of their cruelty, pity, and maternity; of their love, ethics, vanity, and intelligence. These chapters are so many monographs and present normal woman from every point of view. She is described as always inferior to man, because her faculties are less developed. Strange to say, according to Lombroso, she has less feeling than man. This seems a direct contradiction of all legends and traditions. And is it not woman, rather than man, who is the most ardent opponent to all useless suffering; is it not women who have been the chief promoters of anti-cruelty societies, no matter if this cruelty be practiced on human beings or on animals? But the contradiction is explained, according to Lombroso, by the greater excitability of women and their lesser inhibition. As soon as the primitive barbarities of sexual selection began to be mitigated, men chose as wives the prettiest and gentlest instead of the strongest women, so paying tribute to beauty and the moral qualities that are associated with it. Thus women were

perfected in gentleness, grace, and pleasing manners, and withdrew from those qualities that required strength and cruelty. Other influences, not least among which is the longer duration of maternity, cause civilized women to become more compassionate; but in every woman there is an undercurrent of cruelty, which appears either when her nature is wicked or when her strongest feelings, such as those of mother or wife, are attacked. Hence Lombroso adduces that woman's attitude with regard to cruelty and pity is a contradictory one, which will by evolution give way in favor of gentleness and mercy. In the second part of his work Lombroso compares the crimes of female animals with the crimes of primitive and savage women; and in the third chapter he gives a brief history of prostitution, which he considers as one of the great factors in the promotion of crime. Under the heading, "Crimes of Primitive Women," the writer discusses adultery, abortion, infanticide, witchcraft, and poisoning, and concludes thus: "In general, women savages, like other women, commit fewer crimes than men, although their nature is rather worse than better; and the crimes for which they are punished are in great part conventional, such as those contained in *tabu* and witchcraft. What corresponds to crime among men is for savage women prostitution."

In the Pathological and Anthropometrical Anatomy of Female Criminals and Prostitutes, which forms the third part of the book, all the measurements which serve to establish those irregularities from which the criminal school draws its conclusions have been taken with the greatest care. According to Lombroso, they are for women the following: Height, the length of the arms when opened, and the length of the limbs are inferior in criminals—weight being, in relation to their stature, greater in prostitutes and assassins than in ordinary women. The hands are longer and more developed in prostitutes, the foot shorter, the fingers less developed than the rest of the hand. The size and circumference of the skull in female thieves, and even more so in prostitutes, are small; *vice versa*, the facial diameter and especially the jaw are more developed than in normal specimens. The hair and iris are apt to be darker in criminals, and up to a certain point in prostitutes, in whom, however, fair and red hair are often lighter or darker than the normal color. White hair, which is rare in ordinary women, is twice as frequent in criminals; *vice versa*, with them baldness is rarer during youth and middle age than among ordinary women, while wrinkles are more frequent only when they are middle-aged. It has been difficult to gather these facts with certainty about prostitutes, who are nearly all painted and made up even when quite young; but from the data Lombroso had to go upon, precocious white hair and baldness

would be a common defect, as it is in those who are born delinquents. Irregularities of countenance are to be met with in a greater degree in female assassins and poisoners than in infanticides. The real criminal type is rarer among female than male delinquents; it is found more frequently among prostitutes, and according to a still more precise study made by Tarnowsky, there are more female murderers than thieves, while prostitutes are the most numerous of all.

"In short," as our author writes, "female criminals have less typical faces, because they are less criminal than men, and women in every degeneration present fewer digressions than men, because women being organically conservative preserve the average type even in their moral aberrations; besides which, beauty being a supreme necessity for them, this overcomes all the attacks made by moral degeneracy. Still, it can not be denied that when wickedness is deep-rooted, then the general rule which stamps crime with a type, conquers every obstacle, at least in civilized races, and this is particularly the case with prostitutes, because the latter *recall the type of primitive woman much more than female criminals.*"

The third part closes with a fine chapter on tattooing in women, the tendency to tattoo being, according to Lombroso, an infallible indication of criminal tendencies.

The fourth and last part of the work is entitled The Biology and Psychology of Female Criminals and Prostitutes. It is divided into twelve chapters that are crowded with the most minute and subtle researches. The first three treat of female criminals and prostitutes in general; the others make a separate study of women born with criminal tendencies and those who have become criminals through incidental causes, such as love; suicides; women born with a natural inclination to prostitution; women who have become prostitutes through circumstances; insane criminals; epileptic and hysterical delinquents. It is this portion of the work that has required the greatest circumspection. It is so easy here to fall into errors in drawing conclusions from such complicated and various data as presented themselves, and the more, because the variety of subjects examined is very large. Lombroso, in making a *résumé* of the second chapter, observes that fatness of the palm of the hand and irregularities in the pupil of the eye are greater in prostitutes than in female criminals, but are never so marked as in male criminals. The reflections in the pupil of the eye in prostitutes are, however, duller than in male criminals, this being accounted for by the direct action of syphilis on the nervous centers.

Few women are born with criminal tendencies, according to Lombroso; but when this is the case, criminality is more intense

and depraved in them than in men. They prove themselves most cruel, and when compared with normal women they are found wanting in every attribute belonging to the latter. For example, among women born with criminal tendencies there is a total want of maternal affection, pity, and love; they are excessively erotic and revengeful, revenge among women naturally criminals being one of the chief motives for crime. By a curious contrast in this class a mawkish sentimentality, which is particularly apparent in their letters, takes the place of real and strong sentiment. For instance, Avelina wrote to her lover thus: "I am jealous of Nature, which seems to madden us by its beauty. Dearest one, don't you think that this beautiful weather is made for lovers and speaks of love?" Again: "How I wish the undertaking which would render us free and happy were over" (the murder of her husband); "I must succeed in it, as paradise is in view. The turning of the path is full of roses." Lombroso concludes thus: "Since these women are morally insane, and are wanting in all noble and deep sentiments, they exchange them for exaggerated sophistications, just as a coward boasts of a chimerical and absurd courage in his discourses."

Women born criminals are intelligent, and make up for their weakness and want of physical power to satisfy their natural depravity by having recourse to cunning in their fight against society. But as a whole the type of the woman born to be a criminal shows a great likeness to the type of men criminals, and in the rare case of complete criminality women surpass men in wickedness. Females who have become delinquents by accident—and the greater number of female criminals belong to this class—may be divided into two categories: the one represented by females born with only slight criminal tendencies, the other containing delinquents who differ very slightly from normal women, and who sometimes are nothing but ordinary women whose condition in life has been such as to develop that fund of immorality which is latent in every woman. Prof. Lombroso determines by indubitable data the much-debated question of the affinity between prostitution and criminality, concluding that the psychological and anatomical identity between criminals and born prostitutes could not be more complete; both being morally insane, by a mathematic axiom they become equal. In drawing his conclusions on women who have become prostitutes through circumstances Lombroso says that mentally these are more abnormal than women who have become criminals by choice, because, according to the theory of his school, prostitution and not criminality is the true degeneration of woman, innate female criminals being rare and monstrous exceptions. He says: "Chastity is the strongest feminine sentiment after maternity; it is a sentiment

toward which the minds of women have worked for so many centuries in order to create and consolidate it: thus, if a woman, who though not wanting in chastity loses it easily, she must be more deeply abnormal than a woman who when exposed to great temptations forgets to respect other people's property. This fact is almost normal; the other being instead most abnormal. This is the reason that women who have become prostitutes by chance present many of the characteristics of those born with a natural tendency to prostitution; while female criminals who are almost normal have little in common with innate criminals, these last being a double exception from many points of view, and a sporadic monstrosity." The last chapters treat of insane, epileptic, and hysterical criminals.

This terrible but most necessary examination of criminal women occupies a large volume of six hundred and fifty pages. What remedy can be found? This is the subject of the second volume, which will soon appear, and in which Lombroso will speak of the different social importance of crime and prostitution, the two different forms of male and female crime. The present volume is largely illustrated by designs which serve as proofs of the data collected. It is most interesting to see the reproduction of the different types of female delinquents. As usual, Lombroso speaks with the true modesty of a scientific man.

"Not one line of this work," he writes, "justifies the many tyrannies of which women have been and are still the victims—from the *tabu*, which forbids them to eat meat or to touch cocoanuts, up to that which prevents them learning or, still worse, carrying on a profession once they have learned it. These are cruel and overbearing practices by whose means we have certainly contributed to maintain and, what is worse, to increase the inferiority of woman, so as to be able to despoil her for our advantage, while hypocritically we were covering the docile victim with praises which we did not believe, and which were a preparation for fresh sacrifices rather than an ornament."

His love for his science he has again and again abundantly proved. It is deeply interesting to read the conclusion he himself draws from his labors—a conclusion that "all who believe in woman and her future can but rejoice in."

Much suggestive work has recently been accomplished in the domain of chemistry, in the attempt to apply the principle of gravitation to account for the interactions of the molecules of the elements. "So far," says Prof. Reynolds, of the University of Dublin, "the fundamental hypothesis of 'Newtonian chemistry' has led to conclusions which are not at variance with the facts of the science, while it gives promise of help in obtaining a solution of the great problem of the nature of chemical action."

ETHICS AND THE STRUGGLE FOR EXISTENCE.

By LESLIE STEPHEN.

IN his deeply interesting Romanes lecture, Prof. Huxley has stated the opinion that the ethical progress of society depends upon our combating the "cosmic process" which we call the struggle for existence. Since, as he adds, we inherit the "cosmic nature" which is the outcome of millions of years of severe training, it follows that the "ethical nature" may count upon having to reckon with a tenacious and powerful enemy as long as the world lasts. This is not a cheerful prospect. It is, as he admits, an audacious proposal to pit the microcosm against the macrocosm. We can not help fearing that the microcosm may get the worst of it. Prof. Huxley has not fully expanded his meaning, and says much to which I could cordially subscribe. But I think that the facts upon which he relies admit or require an interpretation which avoids the awkward conclusion.

Pain and suffering, as Prof. Huxley tells us, are always with us, and even increase in quantity and intensity as evolution advances. The fact has been recognized in remote ages long before theories of evolution had taken their modern form. Pessimism, from the time of the ancient Hindu philosophers to the time of their disciple, Schopenhauer, has been in no want of evidence to support its melancholy conclusions. It would be idle to waste rhetoric in the attempt to recapitulate so familiar a position. Though I am not a pessimist, I can not doubt that there is more plausibility in the doctrine than I could wish. Moreover, it may be granted that any attempt to explain or to justify the existence of evil is undeniably futile. It is not so much that the problem can not be answered as that it can not even be asked in any intelligible sense. To "explain" a fact is to assign its causes—that is, to give the preceding set of facts out of which it arose. However far we might go backward, we should get no nearer to perceiving any reason for the original fact. If we explain the fall of man by Adam's eating the apple we are quite unable to say why the apple should have been created. If we could discover a general theory of pain, showing, say, that it implied certain physiological conditions, we should be no nearer to knowing why those physiological conditions should have been what they are. The existence of pain, in short, is one of the primary data of our problem, not one of the accidents for which we can hope in any intelligible sense to account. To give any "justification" is equally impossible. The book of Job really suggests an impossible, one may almost say a meaningless, problem. We can give an intelligible meaning to a demand for justice when we can suppose that a man has certain

antecedent rights which another man may respect or neglect. But this has no meaning as between the abstraction "Nature" and the concrete facts which are themselves Nature. It is unjust to treat equal claims differently. But it is not "unjust" in any intelligible sense that one being should be a monkey and another a man, any more than that one part of me should be a hand and another a head. The question would only arise if we supposed that the man and the monkey had existed before they were created, and had then possessed claims to equal treatment. The most logical theologians indeed admit that as between creature and creator there can be properly no question of justice. The pot and the potter can not complain of each other. If the writer of Job had been able to show that the virtuous were rewarded and the vicious punished, he would only have transferred the problem to another issue. The judge might be justified but the creator would be condemned. How can it be just to place a being where he is certain to sin and then to damn him for sinning? That is the problem to which no answer can be given; and which already implies a confusion of ideas. We apply the conception of justice in a sphere where it is not applicable, and naturally fail to get any intelligible answer.

The question therefore resolves itself into a different one. We can neither explain nor justify the existence of pain; but of course we can ask whether, as a matter of fact, pain predominates over pleasure, and we can ask whether, as a matter of fact, the "cosmic processes" tend to promote or discourage virtuous conduct. Does the theory of the "struggle for existence" throw any new light upon the general problem? I am quite unable to see, for my own part, that it really makes any difference: evil exists; and the question whether evil predominates over good can only, I should say, be decided by an appeal to experience. One source of evil is the conflict of interests. Every beast preys upon others, and man, according to the old saying, is a wolf to man. All that the Darwinian theory can do is to enable us to trace the consequences of this fact in certain directions, but it neither reveals the fact nor makes it more or less an essential part of the process. It "explains" certain phenomena, in the sense of showing their connection with previous phenomena, but does not show why the phenomena should present themselves at all. If we indulge our minds in purely fanciful constructions, we may regard the actual system as good or bad, just as we choose to imagine for its alternative a better or a worse system. If everybody had been put into a world where there was no pain, or where each man could get all he wanted without interfering with his neighbors, we may fancy that things would have been pleasanter. If the struggle, which we all know to exist, had no effect in promoting the "sur-

vival of the fittest," things—so at least some of us may think—would have been worse. But such fancies have nothing to do with scientific inquiries. We have to take things as they are, and make the best of them.

The common feeling, no doubt, is different. The incessant struggle between different races suggests a painful view of the universe, as Hobbes's natural state of war suggested painful theories as to human nature. War is evidently immoral, we think; and a doctrine which makes the whole process of evolution a process of war must be radically immoral too. The struggle, it is said, demands "ruthless self-assertion," and the hunting down of all competitors; and such phrases certainly have an unpleasant sound. But, in the first place, the use of the epithets implies an anthropomorphism to which we have no right so long as we are dealing with the inferior species. We are then in a region to which moral ideas have no direct application, and where the moral sentiments exist only in germ, if they can properly be said to exist at all. Is it fair to call a wolf "ruthless" because it eats a sheep and fails to consider the transaction from the sheep's point of view? We must surely admit that if the wolf is without mercy he is also without malice. We call an animal ferocious because a man who acted in the same way would be ferocious. But the man is really ferocious because he is really aware of the pain which he inflicts. The wolf, I suppose, has no more recognition of the sheep's feelings than a man has of feelings in the oyster or the potato. For him, they are simply non-existent; and it is just as inappropriate to think of the wolf as cruel as it would be to call the sheep cruel for eating grass. Are we, then, to say that "Nature" is cruel because the arrangement increases the sum of general suffering? That is a problem which I do not feel able to answer; but it is at least obvious that it can not be answered offhand in the affirmative. To the individual sheep it matters nothing whether he is eaten by the wolf or dies of disease or starvation. He has to die anyway, and the particular way is unimportant. The wolf is simply one of the limiting forces upon sheep, and, if he were removed, others would come into play. The sheep, left to himself, would still have a practical illustration of the doctrine of Malthus. If, as evolutionists tell us, the hostility of the wolf tends to improve the breed of sheep, to encourage him to climb better and to sharpen his wits, the sheep may be, on the whole, the better for the wolf: in this sense, at least, thus the sheep of a wolfless region might lead a more wretched existence, and be less capable animals and more subject to disease and starvation than the sheep in a wolf-haunted region. The wolf may, so far, be a blessing in disguise.

This suggests another obvious remark. When we speak of the

struggle for existence, the popular view seems to construe this into the theory that the world is a mere cockpit, in which one race carries on an internecine struggle with the other. If the wolves are turned in with the sheep, the first result will be that all the sheep will become mutton, and the last that there will be one big wolf with all the others inside him. But this is contrary to the essence of the doctrine. Every race depends, we all hold, upon its environment, and the environment includes all the other races. If some, therefore, are in conflict, others are mutually necessary. If the wolf ate all the sheep, and the sheep ate all the grass, the result would be the extirpation of all the sheep and all the wolves, as well as all the grass. The struggle necessarily implies reciprocal dependence in a countless variety of ways. There is not only a conflict, but a system of tacit alliances. One species is necessary to the existence of others, though the multiplication of some implies also the dying out of particular rivals. The conflict implies no cruelty, as I have said, and the alliance no good will. The wolf neither loves the sheep (except as mutton) nor hates him; but he depends upon him as absolutely as if he were aware of the fact. The sheep is one of the wolf's necessaries of life. When we speak of the struggle for existence, we mean, of course, that there is at any given period a certain equilibrium between all the existing species; it changes, though it changes so slowly that the process is imperceptible and difficult to realize even to the scientific imagination. The survival of any species involves the disappearance of rivals no more than the preservation of allies. The struggle, therefore, is so far from internecine that it necessarily involves co-operation. It can not even be said that it necessarily implies suffering. People, indeed, speak as though the extinction of a race involved suffering in the same way as the slaughter of an individual. It is plain that this is not a necessary though it may sometimes be the actual result. A corporation may be suppressed without injury to its members. Every individual will die before long, struggle or no struggle. If the rate of reproduction fails to keep up with the rate of extinction, the species must diminish. But this might happen without any increase of suffering. If the boys in a district discover how to take birds' eggs, they might soon extirpate a species; but it does not follow that the birds would individually suffer. Perhaps they would feel themselves relieved from a disagreeable responsibility. The process by which a species is improved, the dying out of the least fit, implies no more suffering than we know to exist independently of any doctrine as to a struggle. When we use anthropomorphic language, we may speak of "self-assertion." But "self-assertion," minus the anthropomorphism, means self-preservation; and that is merely a way of describing the fact that an

animal or plant which is well adapted to its conditions of life is more likely to live than an animal which is ill adapted. I have some difficulty in imagining how any other arrangement can even be supposed possible. It seems to be almost an identical proposition that the healthiest and strongest will generally live longest; and the conception of a "struggle for existence" only enables us to understand how this results in certain progressive modifications of the species. If we could even for a moment have fancied that there was no pain and disease, and that some beings were not more liable than others to those evils, I might admit that the new doctrine has made the world darker. As it is, it seems to me that it leaves the data just what they were before, and only shows us that they have certain previously unsuspected bearings upon the history of the world.

One other point must be mentioned. Not only are species interdependent as well as partly in competition, but there is an absolute dependence in all the higher species between its different members which may be said to imply a *de facto* altruism, as the dependence upon other species implies a *de facto* co-operation. Every animal, to say nothing else, is absolutely dependent for a considerable part of its existence upon its parents. The young bird or beast could not grow up unless its mother took care of it for a certain period. There is, therefore, no struggle as between mother and progeny, but, on the contrary, the closest possible alliance. Otherwise life would be impossible. The young being defenseless, their parents could exterminate them if they pleased, and by so doing would exterminate the race. This, of course, constantly involves a mutual sacrifice of the mother to her young. She has to go through a whole series of operations, which strain her own strength and endanger her own existence, but which are absolutely essential to the continuance of the race. It may be anthropomorphic to attribute any maternal emotions of the human kind to the animal. The bird, perhaps, sits upon her eggs because they give her an agreeable sensation, or, if you please, from a blind instinct which somehow determines her to the practice. She does not look forward, we may suppose, to bringing up a family, or speculate upon the delights of domestic affection. I only say that as a fact she behaves in a way which is at once injurious to her own chances of survival and absolutely necessary to the survival of the species. The abnormal bird who deserts her nest escapes many dangers; but if all birds were devoid of the instinct, the birds would not survive a generation.

Now, I ask, what is the difference which takes place when the monkey gradually loses his tail and sets up a superior brain? Is it properly to be described as a development or improvement of

the "cosmic process," or as the beginning of a prolonged contest against it?

In the first place, so far as man becomes a reasonable being, capable of foresight and of the adoption of means to ends, he recognizes the necessity of these tacit alliances. He believes it to be his interest not to exterminate everything, but to exterminate those species alone whose existence is incompatible with his own. The wolf eats every sheep that he comes across as long as his appetite lasts. If there are too many wolves, the process is checked by the starvation of the supernumerary eaters. Man can preserve as many sheep as he wants, and may also proportion the numbers of his own species to the possibilities of future supply. Many of the lower species thus become subordinate parts of the social organism—that is to say, of the new equilibrium which has been established. There is so far a reciprocal advantage. The sheep who is preserved with a view to mutton gets the advantage, though he is not kept with a view to his own advantage. Of all arguments for vegetarianism, none is so weak as the argument from humanity. The pig has a stronger interest than any one in the demand for bacon. If all the world were Jewish, there would be no pigs at all. He has to pay for his privileges by an early death; but he makes a good bargain of it. He dies young, and though we can hardly infer the "love of the gods," we must admit that he gets a superior race of beings to attend to his comforts, moved by the strongest possible interest in his health and vigor, and induced by its own needs, perhaps, to make him a little too fat for comfort, but certainly also to see that he has a good sty, and plenty to eat every day of his life. Other races, again, are extirpated as "ruthlessly" as in the merely instinctive struggle for existence. We get rid of wolves and snakes as well as we can, and more systematically than can be done by their animal competitors. The process does not necessarily involve cruelty, and certainly does not involve a diminution of the total of happiness. The struggle for existence means the substitution of a new system of equilibrium, in which one of the old discords has been removed, and the survivors live in greater harmony. If the wolf is extirpated as an internecine enemy, it is that there may be more sheep when sheep have become our allies and the objects of our earthly providence. The result may be, perhaps I might say must be, a state in which, on the whole, there is a greater amount of life supported on the planet: and therefore, as those will think who are not pessimists, a decided gain on the balance. At any rate, the difference so far is that the condition which was in all cases necessary, is now consciously recognized as necessary; and that we deliberately aim at a result which always had to be achieved on penalty of destruction. So far, again, as morality can be estab-

lished on purely prudential grounds, the same holds good of relations between human beings themselves. Men begin to perceive that, even from a purely personal point of view, peace is preferable to war. If war is unhappily still prevalent, it is at least not war in which every clan is fighting with its neighbors, and where conquest means slavery or extirpation. Millions of men are at peace within the limits of a modern state, and can go about their business without cutting each other's throats. When they fight with other nations they do not enslave nor massacre their prisoners. Taking the purely selfish ground, a Hobbes can prove conclusively that everybody has benefited by the social compact which substituted peace and order for the original state of war. Is this, then, a reversal of the old state of things—a combating of a "cosmic process"? I should rather say that it is a development of the tacit alliances, and a modification so far of the direct or internecine conflict. Both were equally implied in the older conditions and both still exist. Some races form alliances, while others are crowded out of existence. Of course, I cease to do some things which I should have done before. I don't attack the first man I meet in the street and take his scalp. The reason is that I don't expect that he will take mine; for, if I did, I fear that even as a civilized being, I should try to anticipate his intentions. This merely means that we have both come to see that we have a common interest in keeping the peace. And this, again, merely means that the alliance which was always an absolutely necessary condition of the survival of the species has now been extended through a wider area. The species could not have got on at all if there had not been so much alliance as is necessary for its reproduction and for the preservation of its young for some years of helplessness. The change is simply that the small circle which included only the primitive family or class has extended, so that we can meet members of the same race on terms which were previously confined to the minuter group. We have still to exterminate and still to preserve. The mode of employing our energies has changed, but not the essential nature.

Morality proper, however, has so far not emerged. It begins when sympathy begins; when we really desire the happiness of others; or, as Kant says, when we treat other men as an end and not simply as a means. Undoubtedly this involves a new principle no less than the essential principle of all true morality. Still I have to ask whether it implies a combating or a continuation of a cosmic process. Now, as I have observed, even the animal mother shows what I have called a *de facto* altruism. She has instincts which, though dangerous to the individual, are essential for the race. The human mother sacrifices herself with a consciousness of the results to herself, and her personal fears are overcome by

the strength of her affections. She will endure a painful death to save her children from suffering. The animal sacrifices herself, but without consciousness and therefore without moral worth. This is merely the most striking exemplification of the general process of the development of morality. Conduct is first regarded purely with a view to the effects upon the agent, and is therefore enforced by extrinsic penalties, by consequences, that is, supposed to be attached to it by the will of some ruler, natural or supernatural. The instinct which comes to regard such conduct as bad in itself, which implies a dislike of giving pain to others, not merely a dislike to the gallows, grows up under such protection, and in the really moralized being acquires a strength which makes the external penalty superfluous. This, indubitably, is the greatest of all changes, the critical fact which decides whether we are to regard conduct simply as useful or also to regard it as moral in the strictest sense. But I should still call it a development and not a reversal of the previous process. The conduct which we call virtuous is the same conduct externally which we before regarded as useful. The difference is that the simple fact of its utility—that is, of its utility to others and to the race in general—has now become the sufficient motive for the action as well as the implicit cause of the action. In the earlier stages, when no true sympathy existed, men and animals were still forced to act in a certain way because it was beneficial to others. They now act in that way because they perceive it to be beneficial to others. The whole history of moral evolution seems to imply this. We may go back to a period at which the moral law is identified with the general customs of the race; at which there is no perception of any clear distinction between that which is moral and that which is simply customary; between that which is imposed by a law in the strict sense and that which is dictated by general moral principles. In such a state of things, the motives for obedience partake of the nature of "blind instincts." No definite reason for them is present to the mind of the agent, and it does not occur to him even to demand a reason. "Our father did so and we do so" is the sole and sufficient explanation of their conduct. Thus instinct again may be traced back by evolutionists to the earliest period at which the instincts implied in the relations between the sexes, or between parents and offspring, existed. They were the germ from which has sprung all morality such as we now recognize.

Morality, then, implies the development of certain instincts which are essential to the race, but which may in an indefinite number of cases be injurious to the individual. The particular mother is killed because she obeys her natural instincts; but if it were not for mothers and their instincts, the race would come to

an end. Prof. Huxley speaks of the "fanatical individualism" of our time as failing to construct morality from the analogy of the cosmic process. An individualism which regards the cosmic process as equivalent simply to an internecine struggle of each against all must certainly fail to construct a satisfactory morality, and I will add that any individualism which fails to recognize fully the social factor, which regards society as an aggregate instead of an organism, will, in my opinion, find itself in difficulties. But I also submit that the development of the instincts which directly correspond to the needs of the race, is merely another case in which we aim consciously at an end which was before an unintentional result of our actions. Every race, above the lowest, has instincts which are only intelligible by the requirements of the race; and has both to compete with some and to form alliances with others of its fellow-occupants of the planet. Both in the unmoralized condition and in that in which morality has become most developed, these instincts have the common characteristics that they may be regarded as conditions of the power of the race to maintain its position in the world, and so, speaking roughly, to preserve or increase its own vitality.

I will not pause to insist upon this so far as regards many qualities which are certainly moral, though they may be said to refer primarily to the individual. That chastity and temperance, truthfulness and energy, are, on the whole, advantages both to the individual and to the race, does not, I fancy, require elaborate proof; nor need I argue at length that the races in which they are common will therefore have inevitable advantages in the struggle for existence. Of all qualities which enable a race to hold its own, none is more important than the power of organizing ecclesiastically, politically, and socially, and that power implies the prevalence of justice, and the existence of mutual confidence, and therefore of all the social virtues. The difficulty seems to be felt in regard to those purely altruistic impulses which, at first glance at any rate, make it apparently our duty to preserve those who would otherwise be unfit to live. Virtue, says Prof. Huxley, is directed "not so much to the survival of the fittest," as to the "fitting of as many as possible to survive." I do not dispute the statement, I think it true in a sense; but I have a difficulty as to its application.

Morality, it is obvious, must be limited by the conditions in which we are placed. What is impossible is not a duty. One condition plainly is that the planet is limited. There is only room for a certain number of living beings. It is one consequence that we do in fact go on suppressing the unfit, and can not help going on suppressing them. Is it desirable that it should be otherwise? Should we wish, for example, that America could

still be a hunting ground for savages? Is it better that a country should contain a million red men or twenty millions of civilized whites? Undoubtedly the moralist will say with truth that the methods of extirpation adopted by Spaniards and Englishmen were detestable. I need not say that I agree with him and hope that such methods may be abolished wherever any remnant of them exists. But I say so partly just because I believe in the struggle for existence. This process underlies morality, and operates whether we are moral or not. The most civilized race—that which has the greatest knowledge, skill, power of organization—will, I hold, have an inevitable advantage in the struggle, even if it does not use the brutal means which are superfluous as well as cruel. All the natives who lived in America a hundred years ago would be dead now in any case, even if they had invariably been treated with the greatest humanity, fairness, and consideration. Had they been unable to suit themselves to new conditions of life, they would have suffered a euthanasia instead of a partial extirpation; and had they suited themselves they would either have been absorbed or become a useful part of the population. To abolish the old brutal method is not to abolish the struggle for existence, but to make the result depend upon a higher order of qualities than those of the mere piratical viking.

Mr. Pearson has been telling us in his most interesting book that the negro may not improbably hold his own in Africa. I can not say that I regard this as an unmixed evil. Why should there not be parts of the world in which races of inferior intelligence or energy should hold their own? I am not so anxious to see the whole earth covered by an indefinite multiplication of the cockney type. But I only quote the suggestion for another reason. Till recent years the struggle for existence was carried on as between Europeans and negroes by simple violence and brutality. The slave trade and its consequences have condemned the whole continent to barbarism. That undoubtedly was part of the struggle for existence. But if Mr. Pearson's guess should be verified, the results have been so far futile as well as disastrous. The negro has been degraded, and yet, after all our brutality, we can not take his place. Therefore, besides the enormous evils to slave-trading countries themselves, the lowering of their moral tone, the substitution of piracy for legitimate commerce, and the degradation of the countries which bought the slaves, the superior race has not even been able to suppress the inferior. But the abolition of this monstrous evil does not involve the abolition but the humanization of the struggle. The white man, however merciful he becomes, may gradually extend over such parts of the country as are suitable to him, and the black man will hold the rest, and acquire such arts and civilization as he is capable of

appropriating. The absence of cruelty would not alter the fact that the fittest race would extend; but it may insure that whatever is good in the negro may have a chance of development in his own sphere, and that success in the struggle will be decided by more valuable qualities.

Without venturing further into a rather speculative region, I need only indicate the bearing of such considerations upon problems nearer home. It is often complained that the tendency of modern civilization is to preserve the weakly, and therefore to lower the vitality of the race. This seems to involve inadmissible assumptions. In the first place, the process by which the weaker are preserved consists in suppressing various conditions unfavorable to human life in general. Sanitary legislation, for example, aims at destroying the causes of many of the diseases from which our forefathers suffered. If we can suppress the smallpox, we of course save many weakly children, who would have died had they been attacked. But we also remove one of the causes which weakened the constitutions of many of the survivors. I do not know by what right we can say that such legislation, or again the legislation which prevents the excessive labor of children, does more harm by preserving the weak than it does good by preventing the weakening of the strong. But one thing is at any rate clear. To preserve life is to increase the population, and therefore to increase the competition, and, in other words, to intensify the struggle for existence. The process is as broad as it is long. If we could insure that every child born should grow up to maturity, the result would be to double the severity of the competition for support. What we should have to show, therefore, in order to justfy the inference of a deterioration due to this process, would be, not that it simply increased the number of the candidates for living, but that it gave to feebler candidates a differential advantage; that they are now more fitted than they were before for ousting their superior neighbors from the chances of support. But I can see no reason for supposing such a consequence to be probable or even possible. The struggle for existence, as I have suggested, rests upon the unalterable facts that the world is limited and the population elastic, and under all conceivable circumstances we shall still have in some way or other to proportion our numbers to our supplies, and under all circumstances those who are fittest by reason of intellectual or moral or physical qualities will have the best chance of occupying good places, and leaving descendants to supply the next generation. It is surely not less true that in the civilized as much as in the most barbarous race, the healthiest are the most likely to live, and the most likely to be ancestors. If so, the struggle will still be carried on upon the same principles, though certainly in a different shape.

It is true that this suggests one of the most difficult questions of the time. It is suggested, for example, that in some respects the "highest" specimens of the race are not the healthiest or the fittest. Genius, according to some people, is a variety of disease, and intellectual power is won by a diminution of reproductive power. A lower race, again, if we measure "high" and "low" by intellectual capacity, may oust a higher race, because it can support itself more cheaply, or, in other words, because it is more efficient for industrial purposes. Without presuming to pronounce upon such questions, I will simply ask whether this does not interpret Prof. Huxley's remark about that "cosmic nature" which, he says, is still so strong, and which is likely to be strong so long as men require stomachs. The fact is simply that we have not to suppress it, but to adapt it to new circumstances. We are engaged in working out a gigantic problem: What is the best, in the sense of the most efficient, type of human being? What is the best combination of brains and stomach? We turn out saints who are "too good to live," and philosophers who have run too rapidly to brains. They do not answer in practice, because they are instruments too delicate for the rough work of daily life. They may give a foretaste of qualities which will be some day possible for the average man; of intellectual and moral qualities which, though now exceptional, may become commonplace. But the best stock for the race are those in whom we have been lucky enough to strike out the happy combination in which greater intellectual power is gained without the loss of physical vigor. Such men, it is probable, will not deviate so widely from the average type. The reconciliation of the two conditions can only be effected by a very gradual process of slowly edging onward in the right direction. Meanwhile the theory of a struggle for existence justifies us, instead of condemning us, for preserving the delicate child, who may turn out to be a Newton or a Keats, because he will leave to us the advantage of his discoveries or his poems, while his physical feebleness assures us that he will not propagate his race.

This may lead to a final question: Does the morality of a race strengthen or weaken it; fit it to hold its own in the general equilibrium, or make its extirpation by lower races more probable? I do not suppose that anybody would deny what I have already suggested, that the more moral the race, the more harmonious and the better organized, the better it is fitted for holding its own. But if this be admitted, we must also admit that the change is not that it has ceased to struggle, but that it struggles by different means. It holds its own, not merely by brute force, but by justice, humanity, and intelligence, while, it may be added, the possession of such qualities does not weaken the brute force,

where such a quality is still required. The most civilized races are, of course, also the most formidable in war. But, if we take the opposite alternative, I must ask how any quality which really weakens the vitality of the race can properly be called moral? I should entirely repudiate any rule of conduct which could be shown to have such a tendency. This, indeed, indicates what seems to me to be the chief difficulty with most people. Charity, you say, is a virtue; charity increases beggary, and so far tends to produce a feebler population; therefore, a moral quality clearly tends to diminish the vigor of a nation. The answer is, of course, obvious, and I am confident that Prof. Huxley would so far agree with me. It is that all charity which fosters a degraded class is therefore immoral. The "fanatical individualism" of to-day has its weaknesses; but in this matter it seems to me that we see the weakness of the not less fanatical "collectivism."

The question, in fact, how far any of the socialistic or religious schemes of to-day are right or wrong, depends upon our answer to the question how far they tend to produce a vigorous or an enervated population. If I am asked to subscribe to General Booth's scheme, I inquire first whether the scheme is likely to increase or diminish the number of helpless hangers-on upon the efficient part of society. Will the whole nation consist in larger proportions of active and responsible workers, or of people who are simply burdens upon the real workers? The answer decides not only the question whether it is expedient, but also the question whether it is right or wrong, to support the proposed scheme. Every charitable action is so far a good action that it implies sympathy for suffering; but if it implies such want of prudence that it increases the evil which it means to remedy, it becomes for that reason a bad action. To develop sympathy without developing foresight is just one of the one-sided developments which fail to constitute a real advance in morality, though I will not deny that it may incidentally lead to an advance.

I hold, then, that the "struggle for existence" belongs to an underlying order of facts to which moral epithets can not be properly applied. It denotes a condition of which the moralist has to take account, and to which morality has to be adapted, but which, just because it is a "cosmic process," can not be altered, however much we may alter the conduct which it dictates. Under all conceivable circumstances, the race has to adapt itself to the environment, and that necessarily implies a conflict as well as an alliance. The preservation of the fittest, which is surely a good thing, is merely another aspect of the dying out of the unfit, which is hardly a bad thing. The feast which Nature spreads before us, according to Malthus's metaphor, is only sufficient for a limited number of guests, and the one question is how to select

them. The use of morality is to humanize the struggle; to minimize the suffering of those who lose the game; and to offer the prizes to the qualities which are advantageous to all rather than to those which serve to intensify the bitterness of the conflict. This implies the growth of foresight, which is an extension of the earlier instinct, and enables men to adapt themselves to the future, and to learn from the past, as well as to act upon the immediate impulse of present events. It implies still more the development of the sympathy which makes every man feel for the sufferings of all, and which, as social organization becomes closer, and the dependence of each constituent atom upon the whole organization is more vividly realized, extends the range of a man's interests beyond his own private needs. In that sense, again, it must stimulate "collectivism" at the expense of a crude individualism, and condemns the doctrine which, as Prof. Huxley puts it, would forbid us to restrain the member of a community from doing his best to destroy it. If it be right to restrain such conduct, it is right to carry on the conflict against all anti-social agents or tendencies. I should certainly hold any form of collectivism to be immoral which denied the essential doctrine of the abused individualist, the necessity, that is, for individual responsibility. We have surely to suppress the murderer as our ancestors suppressed the wolf. We have to suppress both the external enemies, the noxious animals whose existence is incompatible with our own, and the internal enemies which are injurious elements in the society itself. That is, we have to work for the same end of eliminating the least fit. Our methods are changed; we desire to suppress poverty, not to extirpate the poor man. We give inferior races a chance of taking whatever place they are fit for, and try to supplant them with the least possible severity if they are unfit for any place. But the suppression of poverty supposes not the confiscation of wealth, which would hardly suppress poverty in the long run, nor even the adoption of a system of living which would make it easier for the idle and the good-for-nothing to survive. The progress of civilization depends, I should say, on the extension of the sense of duty which each man owes to society at large. That involves a constitution of society which, although we abandon the old methods of hanging, and flogging, and shooting down—methods which corrupted the inflicters of punishment by diminishing their own sense of responsibility—may give an advantage to the prudent and industrious and make it more probable that they will be the ancestors of the next generation. A system which should equalize the advantages of the energetic and the helpless would begin by demoralizing, and would very soon lead to an unprecedented intensification of the struggle for existence. The probable result of a

ruthless socialism would be the adoption of very severe means for suppressing those who did not contribute their share of work. But in any case, as it seems, we never get away or break away from the inevitable fact. If individual ends could be suppressed, if every man worked for the good of society as energetically as for his own, we should still feel the absolute necessity of proportioning the whole body to the whole supplies obtainable from the planet, and to preserve the equilibrium of mankind relatively to the rest of Nature. That day is probably distant, but even upon that hypothesis the struggle for existence would still be with us, and there would be the same necessity for preserving the fittest and suppressing, as gently as might be, those who were unfit.—*Contemporary Review.*

THE CALUMET IN THE CHAMPLAIN VALLEY.

By Prof. G. H. PERKINS.

OF the many interesting objects which have been found in different localities in the United States none more fully illustrate the artistic skill and taste of the aborigines than do the stone pipes, and it is probably true that they represent the finest work in stone which the Indian was able to execute. In form, though not perhaps in material, the pipes exhibit greater variety and less conformity to conventional types than do other classes of prehistoric objects. No other specimens in our archæological collections recall so completely the ceremonial usages of the Indians as do the pipes; no other objects occupied so important a place among the possessions of the tribe or the individual, as the student of Indian customs soon learns.

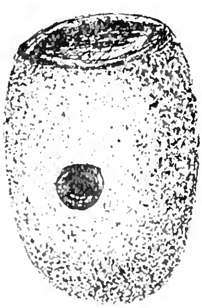


Fig. 1.

Pipes there may have been, and undoubtedly were, many of them of common mold, which were used and regarded very much as are modern pipes, simply as a means of social or personal enjoyment, and these may have been of earthenware, or even of wood or bone, more often than of stone; but the real calumet, the elaborately wrought ceremonial pipe, was a very different affair. With this were associated in the Indian mind the most solemn ceremonies, the most impressive experiences of life. Without the calumet no treaty could be ratified, no war declared, no important tribal or religious question settled. This single object combined in itself a dignity and an essential significance which can hardly be overestimated.

It is not strange, therefore, that the pipemaker should have

exercised his best skill and his most patient labor upon that which he wrought. As Dr. Abbott, in Primitive Industry, well says, "To know the whole history of tobacco, and the custom of smoking and of the origin of the pipe, would be to solve many of the most interesting problems of American ethnology."

The beauty and variety of the pipes which have been found in the Mississippi Valley are unequaled in specimens from any

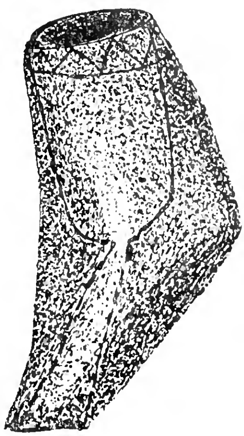


Fig. 2.

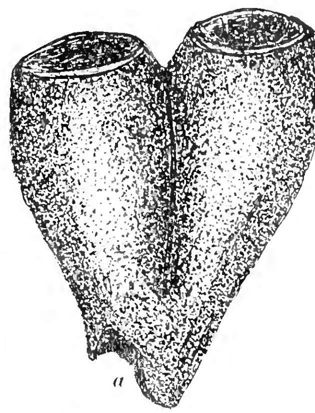


Fig. 3.

other part of the country, and because of this, and because these pipes are so well known, the simpler forms of less favored localities have sometimes been too much overlooked. But the less elaborate New England specimens are not without importance because they have a place in the archæology of the whole country.

In beauty of material and in finish the pipes of the Champlain Valley are quite equal to the best of the mound pipes, but in elaborateness of form they are much inferior. So far as our ancient pipe-makers attempted the execution of any particular form, they usually did very well—that is, unless they destroyed all their failures; but they do not appear to have tried to fashion any very difficult shapes, and very seldom attempted to imitate those animals which were common about them as did the Western tribes. Inasmuch as no two of our pipes are the same in size or form, there is no single type which represents this region.

It is probable that the pipes which have been found in the Champlain Valley were used and, unless obtained in trade or war, made by Algonkins or Iroquois, for these tribes occupied the region from no one knows how early times. Pipes, whether of stone or earthenware, are very uncommon in the Champlain Valley, though diligent search has brought to light a considerable number. In the descriptions and illustrations which are here presented it is the intention of the writer to give a tolerably com-

plete account of such specimens of the class under consideration as have been obtained up to the present time. All the specimens figured are in the collection of the University of Vermont, and all, except Fig. 11, are given of full size.

Our simplest pipes—and it is difficult to imagine a simpler form—are represented by Fig. 1. This is merely a rounded bit of steatite of a grayish color, fairly well shaped and smoothly finished. The excavation is of the same general form as the outside and is very well done. At the top it is rather more than half an inch across. As the figure shows, the opening for the stem is a little below the middle of one side. It is about a fourth of an inch in diameter on the outside, and slopes upward, so that the bowl hung obliquely on the stem. Such a pipe as this must have had some sort of a stem, either a bit of hollow reed, a twig with the pith removed, or the wing bone of a bird.

In Fig. 2 we see a somewhat more elaborate specimen, though the material is very much the same. As the line showing the excavation indicates, the stem, if there was one, entered at the bottom. It is also noticeable that the inside does not at all cor-

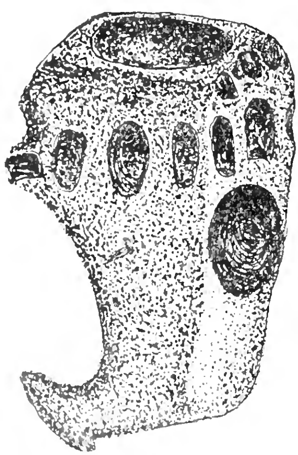


Fig. 4.

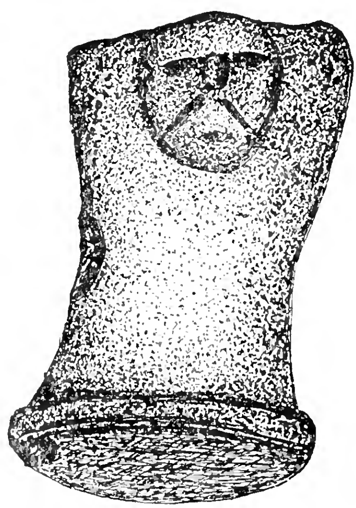


Fig. 5.

respond with the outside, but is more regular. About the upper margin there is a rather weak attempt at decoration in rudely incised lines around the bowl and oblique lines between. This pipe is well polished. It is two inches and a quarter long and seven eighths of an inch in diameter at the top.

No other specimen from this region is in any respect like that shown in Fig. 3. As may be readily seen in the figure, there are two bowls of nearly equal size. The separation of the bowls is,

however, more apparent on the outside than it is inside, since the partition is largely cut away, the two cavities being distinct only at the top and a short distance below it. Most unfortunately, the lower end is broken, so that it is not possible to know exactly how it terminated. Probably, however, this part of the pipe grew narrower and formed a stem or mouthpiece. As is true of most of our pipes, the excavated portion was cut, not bored, for the numerous tool-marks are parallel with the long axis of the bowl; moreover, the openings are not quite circular, as they must have been if the bowl had been drilled out. The opening at the top of each is nearly five eighths of an inch in greatest diameter. The height is about two inches. At *a* is the small opening into the double bowl. The specimen is very well polished. The material is a fine-grained, dark-green steatite. It was found near Swanton, in the northern part of Vermont, as also were those previously described.

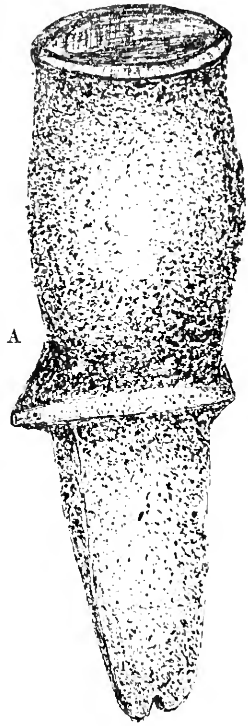


Fig. 6.

Another very unique specimen is seen in Fig. 4. It is apparently intended to represent some quadruped, and if so it is especially interesting, as the only object thus far discovered in this region having the form of an animal. Although a rather clumsy piece of work, I think that there can be no doubt that the maker tried to fashion the pipe after a bear or some other familiar animal. The four legs are well defined, and those on the one side are separated from those on the other by a deep groove. The material is the usual steatite, of a gray color, and the surface is smooth and fairly well polished. As the figure shows, there are about the bowl several oval or quadrangular excavations, which may have been considered sufficiently ornamental in themselves, or they may have been filled by some ornamental bits of stone or shell. As compared with the entire pipe, the hollow of the bowl is small and not much larger than the opening for the stem. The length of this pipe is over two inches and the width is one inch, while the height is a little more.

In an article by the writer in The American Naturalist,* a Vermont pipe is mentioned and figured which has a projection on one side of the rim that may very probably have been intended

* Vol. xiii, p. 735.

for the beak of a bird, and if this is true we have two animal carvings, such as they are, from this region.

In some respects the most interesting of all our pipes is that shown in Fig. 5. Its form is quite peculiar, but the chief importance consists in the carved human faces, one on each side of the top, one of which the figure shows. As may be seen at the base, the pipe is oval in section, the transverse diameter being an inch and a half. The cavity is unusually large and is about three fourths of an inch deep. The stem opening is seen on one side of the figure near the middle, and is about as large as an ordinary pencil. The whole height is over two inches. The faces are in rather bold relief, and of the form seen in the figure; the face on the side not shown is very nearly like that shown. As the figure shows, there are two lines, one from each side of the nose. Do these indicate streaks of paint, or are they intended to represent a mustache and therefore a European face? At the base, which is flat, there is, just below the place where the stem entered, a small hole, as if to enable the owner to attach a thong for suspending the pipe when not in use. The material is very dark steatite. The specimen was found on Grand Isle in Lake Champlain. Only one other specimen having upon it the carving of a face has been found in the Champlain Valley; this is a pipe of oval

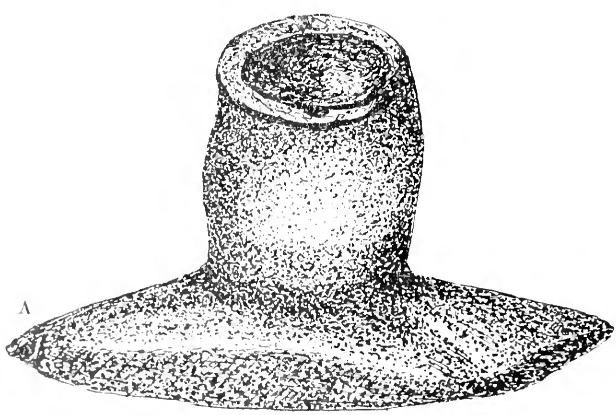


Fig. 7.

section and in general a bag or pouch-like form, bearing in full relief on the edge of the bowl a small but distinctly marked head. Singularly, this face also has lines under the nose, which may, as in the pipe figured, indicate by the mustache a European.

A very regularly shaped and beautifully polished specimen is that shown in Fig. 6. It is three and a half inches long and an inch in diameter at the top. The opening for the stem is at the point marked A, and this is at the bottom of the bowl, the

portion below this being solid. The bowl is polished inside, and ornamented about the top by a series of transverse lines.

The well-known platform pipes of the West and many other localities are not common here, but now and then a specimen is

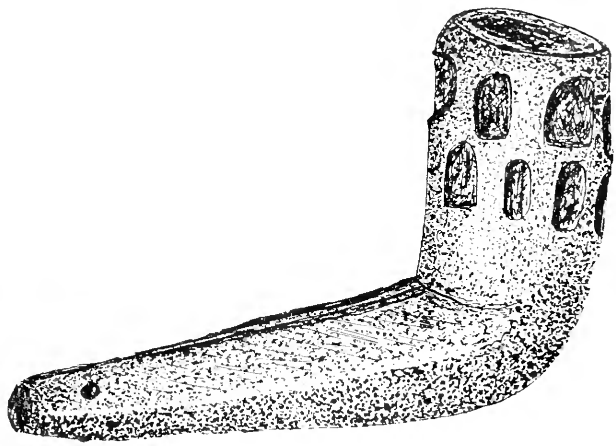


Fig. 8.

found. Fig. 7 gives one of the best of these. It is of a very pretty, light yellow stone, well polished. The opening through which to draw the smoke is at A, and this is so small that it is most probable that no other stem than that afforded by the base itself was used. The platform is nearly three inches long, and the bowl is an inch and a quarter high. The bowl of this pipe differs from that of most of those found here in that it bears circular striæ, and was evidently worked out with a drill.

Pipes of a more modern form than those described, though there is no reason to consider them as actually more recent, are not uncommon among our specimens. The finest example of this class is that shown in Fig. 8, and it is very elegantly finished. The material is a dark, clouded gypsum, hard enough to take an excellent polish. The outside of the bowl was ornamented, like that of Fig. 4, by inlaid pieces of stone, the excavations for which are evident in the figure. There can be no doubt in this case that

Fig. 9.

the cavities were intended not for ornament, but to receive some different material, since they are left in an unfinished state, while the rest of the pipe is unusually well finished. The bowl is pol-

ished inside near the top, but lower, circular striæ are to be seen. The stem is rather thick; the upper surface is made up of two sloping planes, and there is a narrow groove running from the bowl to the end. Measured on the outside, the bowl is two inches high; the stem is about a fourth of an inch longer. Several quite similar pipes have been found on both sides of the lake. A simpler though well-made pipe is that given in Fig. 9. It is not so perfectly polished as the preceding, and is one of the more common sort.

It is well known that no material was so highly valued for making pipes as the famous red pipestone. If the calumet had any ceremonial significance in itself, as it certainly had, this became doubly great if the pipe were made of the red stone. This

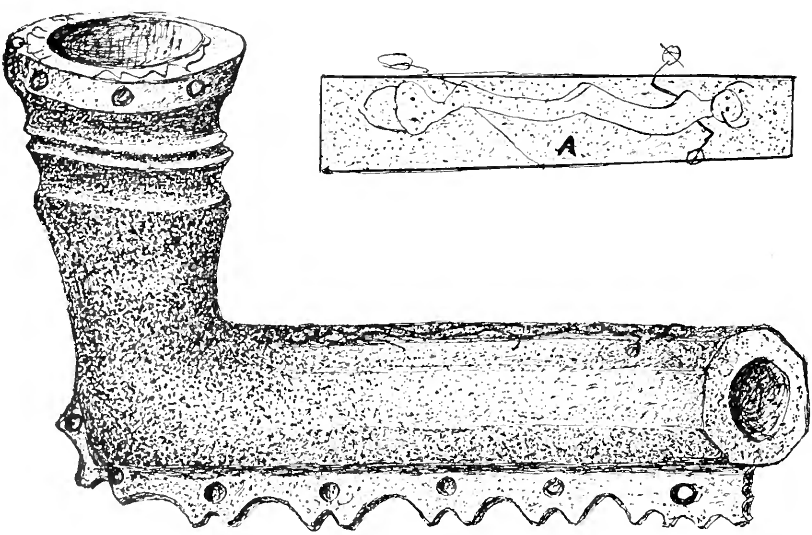


Fig. 10.

material was regarded as the petrified flesh of ancestors and was revered accordingly, and the single quarry where it could be obtained was a very sacred place. We often find this red pipestone mentioned by early writers, and it is strange that specimens made of it are not more often discovered, but they seem to be very rare everywhere, except, of course, those made in recent times.

The single specimen that has been found in the Champlain Valley was thrown out by the plow a dozen miles south of Burlington, and is shown in Fig. 10. It is made of the ordinary dark red catlinite, and has the form given in the figure. It is larger than most of our pipes, the stem being rather more than three inches long and the bowl about two inches and a quarter high. The cavity of the bowl is peculiarly excavated, as it is

strongly conical, being three fourths of an inch in diameter across the top and only a sixteenth of an inch at the bottom. On the flat upper side of the stem there are rudely scratched outline figures, as seen at A, and there are also outlines on the rim of the

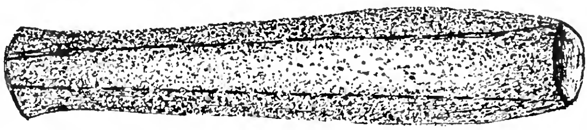


FIG. 11.

bowl. The surface of this pipe is well polished. The inside of the bowl shows both circular and vertical striæ.

Stone tubes, of somewhat different form in different localities, have been found in almost every station which has been carefully searched for archæological specimens, and few objects have excited greater curiosity than these. Always well made, often of handsomely colored and veined stone, they have been regarded as pipes, musical instruments, medicine tubes, and even telescopes, by different authors. When one examines these tubes he very readily sees that it is more than probable that all can not be placed in the same class, for, not only do they vary in size very widely—some being only two inches long and of small diameter, while others are ten, fifteen, and rarely twenty inches in length—but the bore is even more variable, in some being as large as the outside will allow, and of uniform size from end to end; in others it is large at one end and grows smaller toward the opposite end, where it is often of no greater diameter than the bore of some of the pipestems. Very likely the tubes of the first sort were used in the performances of the medicine man, and those last named were used as pipes, as are the very similar pipes smoked to this day by Utes and other West coast tribes. The tubes appear to be everywhere rare, and yet no form of pipe so often occurs in the Champlain Valley, especially on the Vermont side.

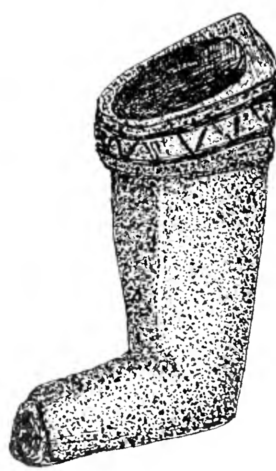


FIG. 12.

Our Vermont tubes have a bore which is very much smaller at one end than at the other, and the small end was, I think, always stopped partially by a rudely ground and imperfectly fitting stone plug, as it certainly was in most cases, for we find the plug in some of the tubes. The general form of the tubes of this region is somewhat differ-

ent in each specimen, but Fig. 11 shows a typical example, the heavier line giving the outline of the bore. This tube is eight inches and a half long, nearly an inch and a half in diameter at the largest part, and about an inch at the smallest. The material —and this is the same in all—is a drab talcose slate. The figure is one third full size. Other tubes have been previously figured and described by the writer in the Portland volume of Proceedings of the American Association for the Advancement of Science. The tubes are all very carefully shaped and well finished. The bore was probably first drilled with a reed and sand, and then at the large end worked out by means of some pointed tool, for circular striæ are plainly seen at the small end, while at the other only longitudinal marks occur. Whatever may have been the design of other tubes, it seems by far most probable that those found here were used as pipes, for they are in all essential respects like those mentioned above, now and anciently in use on the Pacific coast, as may be seen by reference to the seventh vol-

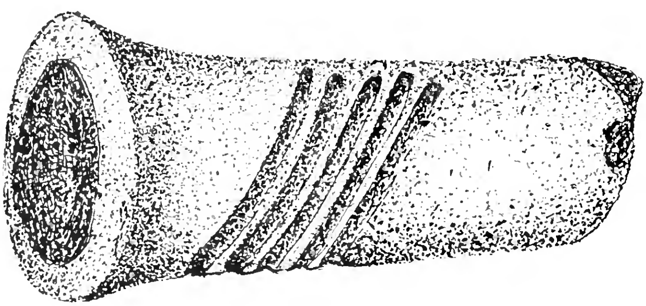


Fig. 13.

ume of the Wheeler Survey, Plates 7 and 8, and also to Volume III of the Contributions to North American Ethnology.

In Fig. 12 there is shown a pipe which may be considered as representing the transition from stone to modern forms; for, although it was dug in a locality that has yielded more of our stone pipes than any other, it is made of pewter. It does not appear as if cast in a mold, but rather as if worked out of a solid block in the same manner that a stone pipe would be made. The surface is covered with tool-marks, and the bowl bears inside both vertical and circular striæ. Of course, the material of which this specimen is made arouses suspicion that it was the work of a white man; but its appearance, as well as the circumstances in which it was found, all indicate that it is of Indian origin. The material was of course obtained from Europeans.

A people who had attained to such skill in working clay into jars as had the aborigines of the Champlain Valley would undoubtedly make many of their common pipes of this material,

and we find numerous fragments of earthenware pipes of various forms, but most of the specimens of this sort are merely fragments. A few entire pipes of the same mixture of clay and pounded stone which we have in the jars are in existence. One of these is shown in Fig. 13. Earthenware pipes of the same general form as that seen in Fig. 8 have also been found, and very likely this was the more common shape. The pipe represented in the figure is unusually thick and heavy, and apparently was made for service rather than ornament. It is three inches long, and the diameter at one end is an inch and a half, at the other about an inch. The bore is rapidly contracted, so that it soon becomes quite small. Most of the earthenware pipes of this region are very smooth on the outside, having received a finishing coat of fine clay, but this is without it, though the surface is tolerably smooth.

THE ESSAYS OF JEAN REY.

By MM. L. A. HALLOPEAU and ALB. POISSON.

AMONG the men of science of the first half of the seventeenth century the name of Jean Rey, doctor, of Périgord, was long forgotten and is still little known. He was born toward the end of the sixteenth century, at Bugues la Dordogne. Hardly anything is known of his life. He was a doctor of medicine, and devoted himself for several years to researches in chemistry and physics, in co-operation with his elder brother, also named Jean Rey, Sieur de la Perotasse, proprietor of the iron forge at Rochebeaucourt, la Dordogne. He died in 1645, and his days may have been cut short by grief over a disastrous lawsuit.

Jean Rey invented a water thermometer, or thermoscope, and a wind arquebus, and he even thought of applying his thermometer to the uses of medicine. It was certainly one of the first instruments invented to measure differences of temperature. In his description of it he said: "It is nothing but a little round vial with a long, uncorked neck. In using it, I place it in the sun or in the hands of a fever patient, after having filled it, all except the neck, with water. The heat, dilating the water, causes it to rise more or less, according as the heat is great or little."

He wrote one little book of a hundred pages, dedicated to the Count de la Tour d'Auvergne, which was printed in 1630, under the title of Essais de Jean Rey, Doctor of Medicine, on an investigation of the cause of the increase in weight of tin and lead when they are calcined. This work was not understood by the learned men of that period. It was probably not very widely published,

and only two copies of the edition existed in the middle of the eighteenth century. But one of these copies was complete. It belonged to the great library of the king. It was, however, reprinted in 1777 by Gobet, who also reprinted, about the same time, the works of Bernard Palissy. After the essays, Gobet published a part of Rey's correspondence with Père Mersenne relative to them, and there are probably still other letters in the manuscript correspondence of Père Mersenne. Rey's book was therefore well published at the close of the eighteenth century. Nevertheless, this edition, too, is now very rare, and only three copies exist in the libraries of France.

As very few persons of this age have read the Essays of Jean Rey, we have thought it might be of service and cast some light on the history of science, obscure in its beginnings, to give a brief but exact analysis of its contents. Judging by his writings, Jean Rey appears to have had very extended scientific knowledge and a talent for experimentation rare in his time. He was, furthermore, in pleasant relations with most of the learned men of the period, who were accustomed to consult him in difficult cases, while he was correctly informed of all that had been done in France and other countries. Three men in particular were closely associated with his works—viz., the Sieur Brun, master apothecary of Bergerac; Deschamps, a physician of the same city; and Père Mersenne, of the order of the Minims, who had a continuous and interesting correspondence with him.

Rey's experiments were undertaken at Brun's request. Brun's letter, giving as it does an idea of the confidence which Rey inspired among his contemporaries and of his high reputation, merits publication entire. He wrote: "Desiring a few days ago to calcine some tin, I weighed two pounds and six ounces of the finest English metal, put it in an iron kettle on an open furnace, and, stirring it continually without making any change in the adjustment, I converted it in six hours into a very white earth. I weighed it to determine the loss, and found that it weighed two pounds and thirteen ounces. This astonished me incredibly, for I could not imagine where the surplus seven ounces had come from. I performed the same experiment with lead, and calcined six pounds. I found it had gained six ounces. I asked the cause of this from many learned men, particularly from Dr. N. (Deschamps), but none of them could explain it to me. Your brilliant mind, which soars, when it is so disposed, above the common, will find matter to occupy itself with in this. I implore you with all my affection to employ yourself with the search for the cause of so rare an effect, and to oblige me so much that by your aid I may be enlightened respecting this wonder."

Rey immediately set himself to work to find the answer to this

question—one of "the most difficult that philosophy has ever brought forth." It was not without emotion that he took up the pen: "Believing I have reached the end of the matter, I produce these my essays, not without well foreseeing that I shall be called rash, for in them I shall disturb some of the maxims that have been approved for ages by most philosophers. But what can there be rash in exposing the truth to the light after having found it?" The book of twenty-eight chapters or essays is divided into distinct parts. In the first part the author, as it were, prepares his reader for the ideas he is about to set forth in the second. He first demonstrates the weight of the air—an entirely new fact in science then—and next he applies the ideas he has just enunciated to the explanation of the weight of lead and tin when calcined in the air.

The great physicists of the seventeenth century had as yet produced nothing when Jean Rey's essays appeared. Otto von Guericke was only twenty-one years old; Torricelli was still studying mathematics at Rome, and his celebrated experiment was not performed by Viviani till 1643. Galileo was the only one who might at that moment have had established ideas on the weight of the air, and his Dialogues on the Motion and the Resistance of Fluids was not published at Leyden till 1638.

Rey was therefore the first person who declared that the air has weight, and he alone has the right to all the honor for this important discovery. His first essay is entitled Everything Material under the enclosure of the Sky has Weight. He supposed that the earth occupied the center of the world. "Matter, filling at every point the space inclosed under the curvature of the sky, is continually urged by its own weight toward the center of the world. True it is that earth, being the heaviest, promptly occupies that place, and, forcing its contraries into retreat, makes water, second in weight, also second in place; so that air, driven from the lowest and the second place, is confined to the third, leaving to fire, the least ponderous of all, to abide in the highest region." Thus Jean Rey showed very precisely that all bodies have weight, that there is nothing light in Nature, and "no upward movement that is natural." Let us give his own words: "I say, if there was a channel from the center of the earth up into the region of fire, open at both ends and full of the four elements, everything in its usual place, that, on drawing the earth down, water would descend to occupy its place, leaving its own to the air, and the air leaving its place to fire. Then, withdrawing the water from that place, the air would come down to fill it; and this, too, being taken away, the fire would take possession of the vacant space and fill the whole channel, descending to the center, just by that being removed which prevented its doing so. Those

who say that this would be done to avoid a vacuum do not say much. They point to the final cause, and this demonstration concerns the efficient one, which rules that there can not be a vacuum." Rey's book, however, while it marked an immense progress in science, contains some considerable errors. Thus, he undertakes in his fifth essay to show, by the acceleration of the motion of falling bodies as they descend, that fire and air are heavy, and he attempts to prove by an ingenious but fallacious demonstration that they are forced down more and more rapidly by the increasing weight of the air and fire above them.

Having tried to "impress upon everybody's heart that air has weight," Rey announced the proposition, then new to science, deduced from this principle, that "weight is so closely joined to the primal matter of the elements, that changing from one to another they always keep the same weight. The weight which each portion of matter takes from its cradle it will carry to its grave. In whatever place, under whatever form, and to whatever volume it may be reduced, always the same weight." This principle, which he discovered more than a century before Lavoisier, was confirmed by a curious experiment of Brun's, who in 1644, having constructed a distilling apparatus, hermetically sealed, inclosed within it wood of guaiac, box, or oak, weighed the whole, and distilled it. The wood was destroyed; but a new weighing, made at the end of the experiment, showed that the total weight of the apparatus had not changed during the distillation. The experiment was a delicate one, and proves that they knew how to work in Rey's time. Mistakenly believing that water could change into air, Rey constructed an apparatus for determining what volume of air a given quantity of water would form. It consisted of a bulb (æolipile) in which water could be boiled, connected by a tube with a cylinder open at the top; a piston was worked in this cylinder. The piston was brought down to the bottom of the cylinder. Heat was applied to the æolipile and the water was made to boil or was "transformed into air"; the piston of course rose, under pressure of the steam or "water air," and the capacity of the part of the cylinder below it showed the volume of the air that was supposed to be formed. Then the æolipile could be removed, the opening from it into the cylinder stopped up, and the cylinder exposed to cold, when the piston would be forced down and the vapor frozen or turned into water. Unfortunately for himself, Rey did not personally try this experiment, or he might have anticipated Papin by half a century. But not more than a year after the publication of his essays—September 1, 1631—Père Mersenne said: "As to the experiments with the æolipile, I have made them; but it is a false imagination to suppose that the water which issues from

it is turned into air; it still remains water, and will naturally return to itself."

Resuming his study concerning the weight of the air, Rey observed that his predecessors had failed to find it because they had weighed the air in itself: " Balancing the air in the air itself, and not finding weight, they have thought that it had none. But let them balance water (which they know is heavy) in water itself, and they will find no weight there too; it being a fact that no element has weight when balanced in itself. Everything that is weighed in the air and everything that is weighed in water should, for an equal volume, have as much more weight as it has more matter than the air or the water in which the balancing is done." Air, he said, could be made heavy by mixing it with some foreign matter having more weight; by compressing its particles; or by removing the lighter portions. In demonstration of the first principle, Rey determined by experiment that moist or cloudy air was heavier than dry air; of the second, he showed that, if a globe was filled by a strong draft of air from a bellows, it would be heavier than the same globe "empty." He even tried to make use of compressed air in the construction of a wind arquebus, but he did not carry out his idea; and the honor of making this invention practical belongs to the Sieur Marin Bourgeois, of Lisieux. Inversely, Rey observed that if one takes a glass vial cold, warms it a little on a chafing dish, and weighs it, he will find that it weighs less, because air has gone out from it; and in order to find how much, the pipe should be put, still warm, into water, which it will suck up till as much water comes into it as air has gone out of it. Rey was, however, not the first who had observed this fact, for Drebbel had anticipated him. The converse of these principles was also enunciated by Rey, viz., that the weight of air may be diminished by purifying it from heavier foreign matter, by extending it to ampler limits, and by extracting its heavier parts. " Even the balance sometimes deceives"; for, " if we examine the balances, cases may be found in which the object weighed will appear heavier or lighter without adding or subtracting foreign matter; as when it has been contracted or expanded." In support of this view, Rey cited as examples the cases of a ball of feathers tightly tied up, which will weigh more than the same feathers loose; and of two ingots, one of gold and the other of iron, which will balance one another without having the same absolute weights, "for the gold occupies a smaller volume for equal weight, and consequently displaces less air." These views were confirmed about 1650 by the inventions of Otto von Guericke.

Rey was now able to answer the question put to him by Brun, and to explain the cause of the increase of weight shown

by tin and lead when they are calcined. "Now," he said, "that I have made my preparations, that is, have laid the foundations of my answer to his question" (as to the source of the seven ounces which the two pounds and six ounces of tin gained when heated for six hours: the difficulty of the problem was enhanced by its being necessary also to find the other matter required to compensate for the loss which the tin sustained through expansion in heating): "to this question, then, resting on the formulations already laid, I answer and maintain gloriously, that the increase in weight comes from the air, which has been thickened in the vessel, made heavy, and in no way adhesive, by the vehement and long-continued heat of the furnace; which air mingles with the earth (the frequent stirring aiding this) and attaches itself to the smallest particles; not otherwise than water makes sand heavy when sand is wet and the mass is stirred, by moistening and adhering to its smallest grains."

Several authors had already spoken of the increase of weight in metals on calcination. Cardan, in his Traité de la Subtilité, tried to explain the increase of the weight of lead in the formation of white lead by saying it was because the lead died and lost the celestial heat which was its soul and made it lighter; and added that an animal is always heavier dead than living. Rey remarked, in answer to this, that lead is void of life and can not be compared with the body of an animal, and showed that it was easy, by a known process, to recover the lead from its earth. Further, "nothing increases in weight except by the addition of matter or by contraction of volume," and this can not take place in the present case, even under Cardan's hypothesis, for the celestial heat in disappearing takes away matter, while on the other hand the volume increases perceptibly through the whole duration of the experiment. It will be noticed that Rey shared in the prejudice of his time in regard to the weight of animals increasing after their death, and with him many of the learned men of the period. Père Mersenne was the first to refute this error. He ascertained by experiment that a dog and a hen weigh more, though very little more, alive than dead, and wrote to Jean Rey, September 1, 1631, "You can yourself try the experiment without losing any of the blood, or a hair, or a feather, of the animals, by smothering them, as we have done."

Scaliger had undertaken to refute Cardan's assertions, and said that the increase in the weight of the calcined lead was caused by the fire consuming its aërated particles, comparing lead with the tile, "which is heavier baked than unburned." Nothing could be more simple than Rey's answer: "If the lead loses airy particles, would it not diminish in volume? On the contrary, it increases. And then, if this reason is correct, why do not

stones and plants increase in weight when they are calcined? I add, finally, that air which is forced into a globe full of it, coming out diminishes the weight of the vessel instead of increasing it, as Scaliger believes." He rejected the comparison of the lead with the tile, saying, "The tile increases in weight by the shrinking of its extent; the lead by the matter that is added to it."

Cæsalpin had supposed, as Libarius records, in explanation of the phenomenon, that the soot produced by the fire struck the roof of the furnace and fell back upon the matter. Rey answered that the soot would blacken the lead instead of communicating a white tint to it. Moreover, if this were the cause, the production of earth might be carried on indefinitely by keeping up the fire, which was not the case. Libarius said that even apprentices in chemistry would laugh at Cæsalpin's theory.

Rey also showed that the increase in weight could not come from the iron vessel in which the calcination took place, for the earth would not continue white in contact with the dust of iron; besides, the vessel would be consumed in two or three operations, instead of being serviceable every day for several years; and, finally, if it was so, we should obtain from a very small quantity of tin or lead a very large quantity of earth, which is contrary to the experiment. Furthermore, a German chemist, Modestinus Fachsius, who also occupied himself with the question, concluded from the examination of the metals, the cupel, the lead, and the metal under trial, that all are heavier after the calcination than before they were exposed to the fire.

Deschamps assumed that the increase of weight was due to vapors of charcoal traversing the vessel. Rey answered that such vapors could not traverse a globe of glass, a plate of tin, or an earthen pot, because boiling water, sauces, and potages were not infected by them. How, then, could they traverse an iron vessel? Even if they did, why should they stop in the earth instead of going on?

Deschamps did not stop with this, but insisted that charcoal had two parts or natures, a vegetable and a metallic nature, and that each of them had two others, one fixed and the other volatile. The fixed part remains in the ashes, from which a fixed salt can be obtained by washing; but the volatile part, being of a mercurial nature, ascends around the vessel; and he made the objection to Rey's proposition that "the volatile part, lifted up on the wings of moisture, meeting the air which is directly on the vessel, being more rarefied and less heavy than the vapor that issues from the coal, is taken up by that in the vessel, and attaches itself by a close sympathy to the fixed salt of the earth of tin, which, having taken a certain quantity of it, and being, as it were, satiated, rejects the surplus." This observation, purely theoretical and made by

a man of science, has a curious appearance now, but was all in place in Rey's time. Rey, who had answered the other objections by argument, had recourse this time to experiment. "If a furnace is built in a wall separating two rooms, in such a way that the vessel shall be on one side and the ventilating registers and doors for feeding in coal on the other, I maintain that the increase in weight will still take place, although no vapors can enter the chamber containing the vessel. I have confirmed this by an experiment which I made at the forges of Jean Rey, Lord of Perrotasse, my elder brother, where I found the increase in tin, which I calcined on a pig, as they call it, or an ingot of sixteen or twenty quintals of iron, at the instant when, coming out of the furnace, it was cast into its mold; for it can not be said that vapors of coal contributed anything to it. Therefore, the volatile salt can not be accepted in this case."

Finally, with a single experiment Rey swept away all the objections in a lump. "I have just read in Homerus Poppius," he said, "in the third chapter of his book entitled *Basilica Antimonii*, of the new way that he practices in calcining antimony. He takes a certain quantity of antimony, weighs it, and having pulverized it, puts it in the shape of a cone on a marble; then takes a burning mirror, holds it in the sun so as to bring the pyramidal point of the reflected rays upon a point of the cone of antimony, which fumes abundantly, and in a little while the antimony, touched by the rays, is turned into a pure white earth, which he separates with a knife and turns the rays upon the rest till all has been turned white, and then the calcination is done. It is a wonderful thing that, although in this calcination the antimony loses much of its substance in the vapors and fumes that exhale from it copiously, its weight increases instead of diminishing. Now, if we ask the cause of this increase, will Cardan say that it is the disappearance of the celestial heat? That has been infused more largely by means of the solar rays. Will Scaliger say that it is by consumption of the airy parts? Thinning into earth and increasing in volume, it forces more in. Will Caesalpin allege his soot? There is no fire to produce any soot. Does the vessel give up any of its own substance? Indeed, the rays are conducted so directly upon the matter that they do not touch the marble. Do you speak of the vapors of charcoal? No charcoal is used in this transaction. The volatile salts which have been so ingeniously brought forward lose here all their savor and grace. Perhaps moisture will be suggested, as has been recently done by some one. But where can it come from? From the marble? No, no, that is not conceivable. From the air? Still less; for the operation is best practiced in the warm days of summer, in the most violent heats of the dog star."

The final objection to his theory was one of Rey's own suggestion: Why does not earth go on increasing in weight indefinitely? Because "the thickened air attaches itself to it and continues to adhere to the most minute of its particles, so that its weight goes on increasing from the beginning to the end; but when it is all enveloped in air it can not take any more." He concludes then, and terminates his treatise by declaring with pride that he has found the real way of the truth, breaking the road for his successors, and advising them not to go astray from it.

This is the summary of the works of Jean Rey. A skillful experimenter, he knew how to use the balance, and it was the balance that suggested to him the result of his experiments. His book is a brief one. A single principal experiment is described, a single object is pursued in it. But he made two great advances in science. He discovered the weight of the air, being the first to publish that hypothesis, and verified it by experiments in chemistry and physics. The increase of the weight of lead and tin on calcination had been noticed for a long time by the alchemists, and even Galen knew of it. But nobody before Rey found that the cause of that increase in weight came from the air—from that thickened and heavy air. It was certainly a remarkable achievement to announce such a fact at a time when chemistry had made so little advance. No gas was yet known; and it was not till about 1719 that a misunderstood man of science, Mortrel d'Élément, found means to decant air through water into bottles, and taught in a public lecture in Paris "how to make air visible and perceptible enough to measure it in pints or in whatever quantity you will." It was not his fault, therefore, that he did not advance further.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

As a possible solution, or working hypothesis, of the reason of the migration of birds, Canon Tristram suggests: "Instinct in mammals and birds attracts them to the place of their nativity. When the increasing cold of the northern regions, in which they all had their origin, drove the mammals southward, they could not retrace their steps, because the increasing polar sea, as the arctic continent sank, barred their way. The birds reluctantly left their homes as winter came on and followed the supply of food. But as the season in their new residence became hotter in summer, they instinctively returned to their birthplaces, and there reared their young, retiring with them when the recurring winter impelled them to seek a warmer climate. Those species which, unfitted for a greater amount of heat by their more protracted sojourn in the northern regions, persisted in revisiting their ancestral homes, or getting as near to them as they could, retained a capacity for enjoying a temperate climate, which, very gradually, was lost by the species which settled down more permanently in their new quarters, and thus a law of migration became established on the one side, and sedentary habits on the other."

SKETCH OF SIR DANIEL WILSON.

By HORATIO HALE.

THE late President of Toronto University was distinguished not only for his educational work and his achievements in science, literature, and art, but also for the happy combination in his mind and character of qualities which are commonly deemed incongruous. An ardent votary of science, prepared to follow every investigation of Nature to the utmost limit of actual knowledge, and to welcome every accession to this knowledge, he was equally firm in maintaining his belief in the religion which explained to him those mysteries of the universe that lay beyond this limit. Strongly conservative of ancient landmarks in his quality of artist and antiquary, he was in education and in politics fearlessly liberal and progressive. Endowed with an energy of will and an intellectual power which inevitably brought him to the leadership of any enterprise or institution in which he took part, he was at the same time utterly devoid of personal ambition, and shrank from titular honors with the same earnestness with which some are wont to seek them. Generous almost to a fault and careless of the arts of money-making, his natural foresight and indefatigable industry preserved him from the pecuniary troubles by which scholars and writers are too often hampered, and secured for him throughout his life that good fortune for which poor Burns vainly sighed, "the glorious privilege of being independent."

Sir DANIEL WILSON was born in Edinburgh on the 3d of January, 1816. His father, Archibald Wilson, was a merchant of that city; his mother was a woman of rare natural gifts, who fostered in her children the love of knowledge which they inherited from her. Of a large family, only four—two sons and two daughters—survived to mature age. The sons, George and Daniel, both proved to possess talents which insured them early distinction. George, a physician, became Regius Professor of Technology in the University of Edinburgh and Director of the Industrial Museum of Scotland. Though he died at the early age of forty-two, he had already gained a European reputation. To his biography, written by his sister, Daniel contributed reminiscences which are of interest as indicating the existence in childhood of tastes which afterward became prominent. "Edinburgh," he writes, "was the scene of all our youthful years, and that itself was no unimportant element in life's training. Among my earliest recollections are scramblings on Arthur's Seat, where we knew every cleft and gully. A Saturday's ramble carried us away to old Roman Cramond, where the sculptured eagle of the legionaries of the second cen-

tury, still visible on the rocks, was a source of never-failing wonder to us. The ruins of Bothwell and Crichton Castles, of Roman camps, and historical scenes already possessed an interest for us. A good deal of antiquarianism mingled with our natural history, and two of us were already embryo numismatists, and knew a Roman denarius from a bodle as well as Edie Ochiltree himself."

Daniel's education was commenced in the famous High School of Edinburgh, whence he passed to the still more famous university of that city. At this period the special turn and capacity for art which he always retained was so strong as to induce him, on his graduation, to decide to make the pursuit of it his profession. With this object he removed to London, where a notable group of great painters was then rising into fame. At their head was Turner, with whom he soon became intimate. He describes him as an "old, slovenly, slouching little man, as remote from the ideal of artist or poet as could well be conceived; but the flash of his keen gray eyes redeemed the face from the otherwise vulgar and sensual look." The door of the strange house in Queen Anne Street was freely open to the young student; and he found in his repeated visits that the great painter could be kind and genial to an enthusiastic youth, while grimly ridiculing his enthusiasm.

In 1840 Wilson brought to London as his bride a Scottish lady. They had three daughters, the first of whom was born in London. She died ten months later, when with her mother visiting the old home. This affliction changed the course of the parents' life. They decided to return to Edinburgh, and Wilson, giving up art as a life-pursuit, devoted himself to literature. His diligent pen and varied talents soon found ample occupation. "He was," we are told by one of his biographers, "a constant contributor to The Scotsman, and wrote for Tait's Magazine, Chambers's Miscellany, the British Quarterly, North British Review, Edinburgh Philosophical Journal, Gentleman's Magazine, and other periodicals. He contributed articles to the edition of the Encyclopædia Britannica then in progress, as well as to subsequent issues, and he edited for a time the Proceedings of the Scottish Antiquary. He also prepared for friendly publishers some historical books, which, though creditably written, he afterward refused to include in the list of his acknowledged writings, counting them mere compilations and craftsman's work, as distinguished from the productions of original research, to which he was soon to owe his fame.

The first of these was published in 1848, under the title of Memorials of Edinburgh in the Olden Time, by Daniel Wilson, Acting Secretary of the Society of Antiquaries of Scotland. It filled two quarto volumes, illustrated throughout with fine engravings of the buildings and localities described, all from his own drawings. The pictures are enlivened by characteristic

figures of people engaged in their ordinary vocations, presented with a life and spirit which show how far superior in these qualities the higher efforts of the draughtsman's art are to the best photography. The description and historical explanations evince deep research, combined with a genial temper and lively humor, which make the work attractive reading. It has been twice reprinted, the latest revised edition appearing in 1890. In his next publication the author found a subject of wider scope, and assumed a higher position. He had passed from art to literature, from literature to archæological study, and now emerged on the loftier plane of pure science, to which his intellectual tastes and faculties naturally tended. In 1851 appeared his Archæology and Prehistoric Annals of Scotland, which was revised and reproduced in two volumes as Prehistoric Annals of Scotland, in 1863. The expressive adjective "prehistoric," which was first employed in this title and work, has since made its way into the language of almost every civilized nation, and in France constitutes, as *Le Préhistorique,* the title of an important science. In his preface the author dwells earnestly on the importance of this science of prehistoric man, and expresses his surprise that "the British Association, expressly constituted for the purpose of giving a stronger impulse and a more systematic direction to scientific inquiry, embraced within its original scheme no provision for the encouragement of those investigations which most directly tend to throw light on the origin and progress of the human race. Physical archæology was indeed admissible, in so far as it dealt with the extinct fauna of the paleontologist; but it was practically pronounced to be without the scientific pale whenever it touched on that portion of the archæology of the globe which comprehends the race of human beings to whom we ourselves belong." A delusive hope had been raised by the publication, in the first volume of the Transactions of the Association, of "one memoir on the contributions afforded by physical and philological researches to the history of the human species"; but the ethnologist was doomed to disappointment. From that time all papers relating to this important branch of knowledge had been constantly rejected. It was no small triumph for Sir Daniel Wilson when, thirty-three years later, at the Montreal meeting of the British Association, in 1884, in which he held a prominent position, anthropology was admitted to the rank of a distinct "section," and a committee was appointed, of which he was a member, to investigate the tribes of northwestern Canada—a committee from which very extensive reports of "physical and philological researches" have been warmly welcomed by the Association, and have formed a conspicuous feature of its recent volumes.

The publication of this work changed his entire career. The

high reputation which it gave him—a reputation sufficiently indicated by Hallam's opinion that the book was "the most scientific treatment of the archæological evidences of primitive history that had ever been written"—procured him the appointment, in 1853, to the chair of History and Literature at University College in Toronto. He removed to that city, and, as one who knew him and the colony in those days has written, "he brought a new element into the life of the place, and indeed of the province. Representing 'letters,' and winning favor to them by his eloquent speech, in a community too much absorbed in business, he has left his mark clear and deep on young Ontario and the whole Dominion. Thousands have been consciously benefited by his character, life, and works." From this time till his death, nearly forty years after, his life was bound up with the interests of the college. It was his boast that for thirty years he never omitted a lecture. The work of his professorship harmonized with his tastes, and gave him a field in which his powers were soon felt. "As a lecturer in history," we are told, "he was noted for the breadth and liberality of his views, and for the spirit of toleration and courtesy which he displayed toward those who differed from him. In archæology and ethnology, subjects peculiarly his own, he never failed to excite interest, and generally succeeded in arousing no small degree of enthusiasm."

But other and less congenial duties were frequently cast upon him. The large endowment granted by the Government to the secularized university was deemed by the denominational colleges an injustice and an injury to themselves. A determined effort was instituted by their supporters to secure a division of it among the different colleges. An appeal was made to the Legislature, which referred the question to a committee. Before this committee, Prof. Wilson, as the foremost member of University College, was appointed to appear and defend the interests of his college and the cause of secular education. This he did with so much force of argument that the hostile attempt was promptly defeated, and was never afterward renewed. All controversy was distasteful to him, but when a cause dear to him was endangered, and the "perfervid Scottish temper" was once aroused, he could strike heavy blows. In the present case the usual reluctance was felt, but finally, he wrote, "I plucked up heart of grace, and found a grim satisfaction in mauling the assailants of our college militant."

In 1880, on the death of the Rev. Dr. McCaul, who was the first President of University College, Prof. Wilson was promoted to that office. The position gave at last the needed opportunity for the display of his remarkable energy and organizing talent, always directed by a judicious forethought and impelled by an un-

tiring zeal. In a sketch written soon after his death, we are told that "the twelve years of his *régime* have been marked by an extraordinary rapidity of development in various directions. The attendance of students has greatly increased, so that they now number about five hundred in the faculty of arts alone. The teaching medical faculty has been restored to the university, and is now in a highly prosperous condition. A foundation for a law faculty has been laid. The university has been brought into more effective and beneficial relation to the secondary schools, by the establishment of a co-operative supervision over their leaving examinations. During the past six years women have been permitted to attend lectures in the university and University College, their number being now about one fifth of the whole attendance, and the ratio rapidly increasing. Several additional institutions have been taken into affiliation with the university, which has thus been strengthened with the whole community, as well as with many special and powerful interests."

As originally established, the University of Toronto and University College were to a certain extent distinct institutions. The university was simply an examining and degree-conferring corporation, while University College was a teaching institution, with a faculty of arts. By a recent change, part of the teaching function, comprising all the work in science, philosophy, and history, has been transferred to the university; and as a result, the President of the College became actually, as he had been in common parlance, the President of the University.

For the interests of science and literature it was probably fortunate that Prof. Wilson's accession to the college presidency, with the consequent great increase in his scholastic duties, did not occur at an earlier day. During the twenty-seven years which elapsed between his arrival in Toronto and this accession, he had leisure to pursue his studies in various directions. In 1862 appeared his most important work, entitled Prehistoric Man: Researches into the Origin of Civilization in the Old and the New World. This work attracted much attention on both continents, and gave a new direction, particularly in Germany, to anthropological inquiry. A second edition appeared in 1865, still in one volume. The continuing demand and the growth of scientific knowledge called for a new and revised issue, with many additions, which appeared in 1875, in two large and finely illustrated volumes.

The author's literary taste and judgment were happily shown in his admirable book, Chatterton: a Biographical Study, which appeared in 1869. It was a thoroughly successful effort to rehabilitate the moral character of the "marvelous boy," as well as to display the real nature and extent of his surprising intellectual

powers. The attraction which drew the biographer to his subject was doubtless the similarity of archæological and poetical tastes. Early in life he had published—like Chatterton, under an assumed name—a little volume of verse, entitled Spring Wild Flowers: Poems, by Wil. D'Leina, of the Outer Temple. By request of the publisher, the collection was reprinted in 1875, with the author's name, and with a modestly deprecatory preface, in which he solicits indulgence for these "sins of his youth." But an impartial critic would find nothing to offend and much to be admired in the volume. Caliban: The Missing Link, appeared in 1873, a genial, half-humorous, and wholly shrewd and happy commentary on Shakespeare, Darwin, and Browning, full of keen suggestions, which the admirers of those famous authors would do well to study with care. The vivid recollections of his early home appeared in his Reminiscences of Old Edinburgh, published in 1875, in two charming volumes of mingled history, description, and gossip, beautifully illustrated by pen-and-ink sketches from the author's hand, in his peculiarly vivid and animated style. Among other claims which may be made for this work is that of being the best commentary (next to Scott's own) on the famous "Scotch novels" of the author's illustrious townsman.

For a time the duties of the presidency interrupted Sir Daniel's authorship. But in 1891 appeared a volume on Left-handedness, comprising, as a reviewer remarked, "a careful and comprehensive discussion of the origin and nature of the prevailing distinction between the uses of the two hands and the consequences which follow this distinction." Sir Daniel was himself left-handed; but, like other eminent men who have been subject to this apparent disability—including a personage no less distinguished than the illustrious artist and mechanician, Leonardo da Vinci—he was able to convert it into an advantage by the simple process of cultivating the use of his right hand, and thus making himself ambidexterous. He was accustomed to write with his right hand and draw with his left; and both his handwriting and drawing were of unusual excellence. This volume was followed in 1892 by his latest work—and, as it proved, a posthumous publication—entitled The Lost Atlantis and other Ethnographic Studies. This was a collection of essays on various ethnological and archæological subjects, reprinted from the Transactions of scientific societies, and chiefly from those of the Royal Society of Canada. The volume of four hundred pages comprises only eight essays, but each of them, as a reviewer has said, "is a complete monograph on the special subject to which it relates; and every subject has its peculiar interest and value to students of history and the science of man." These subjects comprise, besides the well-known Atlantis legend, The Vinland of the Northmen, Trade

and Commerce in the Stone Age, Pre-Aryan American Man, The Æsthetic Faculty in Aboriginal Races, The Huron-Iroquois—a Typical Race, Hybridity and Heredity, and Relative Brain-weight and Size. The volume may be said to fitly sum up its author's life-long studies of these important topics.

But this anticipates. Sir Daniel's later years were marked by events of grave moment. In 1885 a great and irreparable personal loss befell him in the death of his wife, "after forty-five years of as great wedded happiness as ever fell to the lot of man." The event made little change in his outward demeanor; but how deeply it affected him was shown three years later, when the honor of knighthood was unexpectedly bestowed upon him. In general, as has been said, he cared nothing for merely titular distinctions. For her sake, to gratify her wifely pride and affection, this honor might have been acceptable. As it was, he at first positively declined to accept the title. But pressure from all sides came upon him. He wrote in his own amusing vein: "I have had the honor and glory of knighthood for a full week—telegrams, cable messages, letters of congratulation, time for little else but replying. To a jolly old bumble-bee the process of feeding on honey and being smothered in rose leaves is probably the ideal of happiness; but to a wingless biped like myself a little goes a long way. And what are most covetable honors, now that my Maggie is gone?" But the friendly urgency proved too great for resistance, and he yielded at last to the general desire of the community, which, reasonably enough, saw in the title simply an evidence of well-earned respect and public gratitude.

Not long afterward, his unremitting labors for the advancement of his university were interrupted by a serious calamity. On the 14th of February, 1890, a fire broke out in the principal college building, which destroyed nearly the whole of its contents, including its fine library of thirty-three thousand volumes and most of its museum collections. The president's action was characteristic. Instead of being depressed by the blow, as might have been expected in a man of seventy-four, his spirit rose with the occasion. He was early on the ground, giving every assistance in his power to rescue what could be saved. Returning home late at night, he said to one anxiously watching for him: "Well, the old building's gone; but never mind. It wasn't large enough for us. We'll soon have a better one." To a colleague who came in a few minutes later, saying, "O Mr. President, don't be discouraged," he replied: "Discouraged! I should think not. You'll see, we'll soon have a far finer building." Before sleeping that night he had formed his plans. On the next day, which happened to be Saturday, he so arranged for Monday's lectures being held in various buildings kindly placed at his disposal, that

the college and university work continued without the interruption of a single lecture. Hundreds of letters poured in, but not one of them was left without a suitable reply. "Courtesy does not cost much," was his frequent answer, when urged to take no notice of seemingly trivial letters. Encouraged by public sympathy, and bent on seeing his much-prized university more than itself again, he seemed to renew his youth. "Sir Daniel is the youngest man in college," was a common saying at the time. "I mean," he wrote, "not to bate heart or hope; but trust, near as I am to the goal of life, to see the renovated pile in its old beauty, and vastly improved within." This hope was fulfilled, mainly, it may be said, through the influence of his own great reputation and the character for liberality of comprehension, irrespective of class, creed, or race, which he had stamped upon the institution. Offers of substantial aid to the building fund, the library, and the museum came from numerous and often unexpected quarters in Europe and America, including a generous contribution from the Legislature of Roman Catholic Quebec. So rapidly was the work of renovation pushed on that at the college "commencement" of 1891 he was enabled to give his presidential address—one of the most eloquent and brilliant, and unfortunately, as the event proved, the last of his efforts in that line, in one of the new halls; and before his death the restoration of the university, in a condition far superior to that which it held before the fire, had been practically completed.

Among other honors it may be mentioned that he received the degree of LL. D. from the University of Aberdeen, and later also from McGill University, of Montreal, of which, at an earlier day, he had been offered the presidency. He was for several years President of the Canadian Institute of Toronto, the leading scientific association of Ontario. When the Royal Society of Canada was founded by the Governor-General, Lord Lorne, he was at first made president of its Literature Section, and three years later was elected president of the society. He was a member of various learned societies in Europe and America, too numerous to mention. In religious and charitable associations at home he was an active worker. He aided in founding Wycliffe College in Toronto, and was at his death a member of its governing board. The newsboys of the city attracted his special care, and it was mainly through his efforts that the "Newsboys' Home," a most useful and well-managed charity, was founded and maintained.

Near the close of his life one special honor came to him which he highly prized. In the summer of 1891 he paid his last visit to Scotland. While he was there, the "freedom" of his native city was, with much public ceremony and cordial demonstration, conferred upon him, and he thus happily "renewed his youth as the

youngest burgess of the guild." His portrait was also painted by request, that it might have a place in the Scottish Portrait Gallery. It now hangs there, an admirable work of art by Sir George Reid, President of the Scottish Academy. To Sir Daniel, Edinburgh was (in his own words) "as Jerusalem was to the royal Hebrew, or the city of the violet crown to the old Athenian"; and these marks of the esteem and personal regard of his early friends and their children were specially grateful and cheering. On his return home the elasticity of his spirits was noted by his friends and correspondents. A busy winter followed, in which his energy and intellectual force showed themselves in no way abated. Then, almost suddenly, the end came. A brief and nearly painless illness closed with his death on August 6, 1892, in the seventy-seventh year of his age.

His life was, as he himself said, "a singularly happy one." "I have been fortunate," he wrote, "beyond my deserts, and seem to have had far more than my share of God's best gifts." The qualities which insured this singular happiness appear to deserve particular note. A naturally sanguine and sunny temperament had doubtless much to do with it, but the main element was unquestionably his entire unselfishness. His thoughts were constantly for others, and were only for himself so far as the power of serving others was concerned. This disposition was quickly evident to all with whom he came in contact, and was evinced in many ways, great and small. "His colleagues," we are told by one who knew him intimately, "noted his extreme thoughtfulness for others and forgetfulness of self. This naturally led to harmonious relations and strong attachments. One writes, "My friendship for him is one of the sweetest recollections of my life"; and he was not alone in the expression of such a feeling. In his students he took a deep personal interest, frequently inviting them to his house. In their debating societies, sports, and Young Men's Christian Association they could always rely on his practical sympathy. No length of years diminished his interest in a former student's fortunes. The result was a strong affection for him, which was displayed whenever an occasion offered.

A striking characteristic, we are told, "was his unfailing fun. It made his home a very merry one. His letters are full of it, and remind one of Thackeray in their humor. With his students a joke was a more potent weapon for maintaining order than a reproof. He would cleverly turn the laugh of the class against some idler or disturber of the peace. Senate and council meetings were relieved of their tedium by his ready wit; and when in good spirits—and he was rarely otherwise—he was a great acquisition to any social gathering. In early days he wrote valentines for his daughters, and was found out in delivering one of

them by losing his spectacles, which had to be recovered the next day."

He shone as a correspondent. Few idle men kept up so large a correspondence as this extremely busy one. His letters, frank, cordial, sympathetic, full of lively touches, apt suggestions, and pleasant reminiscences, were highly prized by all who were favored with them, and gave naturally to strangers who read them a most pleasing impression of the writer's character. The fortunes of his friends were always in his mind. Nothing of joy or sorrow could happen to one of them without eliciting from him a letter of sympathy, which exactly fitted the need. The dumb animals about him—"My poor relations," as he was wont to style them—shared his tenderness. Long after his death, "a favorite cat haunted his vacant study, evidently seeking the friend who would rather resign his favorite chair than have her disturbed." His benevolence was not undiscriminating, as the regulations of his "Newsboys' Home" sufficiently show; but in his private charities he allowed himself a freer hand and, so to speak, a willing credulity. "He was a perfect fortune to beggars. Taken in again and again, every new applicant seemed to him 'a very decent-looking fellow,' especially if he happened to be Scotch. And if nothing else could be said, he would excuse his generosity by 'It's hard to be poor,' or 'I was once poor myself.' He did, indeed, note that the word 'borrow' seemed to have no connection with that other word 'repay'; but he went on lending still." A poor woman who, coming to ask for him, found crape on the door, went away saying, "The blessing of those that consider the poor will surely fall on him and his."

It is easy to predict that this singularly fine character, illustrious for many great qualities and achievements, and with no shadows except such pardonable failings as "lean to virtue's side," will shine brighter in becoming better known, and will be hereafter ranked among the beacon-lights of the age. In the scientific world, the large-minded and far-seeing scholar, who first gave a place and a name to the science of "prehistoric man," must always be a conspicuous figure.

In his presidential address before the Geographical Section of the British Association, Mr. Henry Seebohm expressed the opinion that life areas or zoögeographical regions are more or less fanciful generalizations. Animals recognize facts, and are governed by them in the extension of their ranges; they care little or nothing about generalizations. The mean temperature of a province is a matter of indifference to some plants and to most animals. The facts that govern their distribution are various, according to the needs of the plant or animal concerned. Actual temperature governs them, not isotherms corrected to sea level.

CORRESPONDENCE.

A CRITIC CRITICISED.

Editor Popular Science Monthly.

ANY one who reads the book notices in journals wherein literary criticism is conducted as it is in many important newspapers will be impressed with the necessity of abolishing the custom of anonymous reviews, if we are to have any criticism worth anything. Under the present system such notices are the work largely of flippant critics, competent only to frame condemnatory epithets, who assume to judge everything without special knowledge of anything; and also of those who have special acquaintance with the topic in hand, but are consumed by feelings of jealousy which prompt them to underrate, to disparage, to stab in the back, to break down reputations acquired, or to prevent the acquiring of any on the part of new authors who may apparently be rising. All these things can be done and are done constantly under the system of anonymous criticism. The critic is safe in his concealment, and can send forth his poisoned arrows with impunity. Whether he is a giant or a dwarf can not be known, save, perhaps, by his weapons; but if, as is usually the case, he is a pygmy, he is not less dangerous, since retaliation is impossible.

The New York Evening Post of October 25, 1893, contains a notice of Mr. Herbert Spencer's latest volume, Parts V and VI of the Principles of Ethics, which furnishes a complete illustration of the degradation of criticism. If there were space I would ask the editor of The Popular Science Monthly to reprint it as such, without comment. But, since the article can not be reprinted, I shall draw attention to one or two of its features. It begins by assertions of the marvelous dullness of Mr. Spencer's works, his "cheap and superficial platitudes," making him "an accomplished artist in tedium." This certainly is a novel charge to be brought against the author in question. Of all the modern philosophical writers, according to the general judgment expressed in numberless reviews, notices, and comments published here, there, and everywhere, Mr. Spencer has been esteemed the one most free from the quality of tediousness! His power of holding the reader's attention without wearying, his lucidity of statement, his felicity in illustration, make his books eminently readable. Of course, they imply a capacity to take hold of thought, but, if this be presupposed, few readers will call Mr. Spencer dull. As to the matter of platitudes, it never occurs to the average reviewer that criticising a scientific writer on this score is often much like criticising a sculptor or painter because his work is true to life. If the philosopher keeps within his topic, it is evidence of his greatness that his statements are so clear, so true, that they seem indisputable. It is his crowning excellence that he says things which the reader recognizes as so evident that he believes he himself and everybody else must always have held the same ideas.

The writer in the Post endeavors to disparage Mr. Spencer's work by the old charge that he is no scholar, that he reads little and knows little of the progress of modern thought. He claims that Mr. Spencer has admitted his ignorance of Kant and is not familiar with German idealism, while the list of authorities he cites is "crude and uncritical material." It is difficult to deal with these charges of little scholarship and failure to know what is significant in philosophical literature, in any other way than by a flat contradiction. That Mr. Spencer has not read everything in German philosophy, or in recent philosophical literature of other countries, is no doubt true, but any one who knows Mr. Spencer's habits is well aware how careful he is to ascertain what literature is produced from time to time and its bearings upon philosophical truth. For an ignorant man and one who takes no note of what is passing in the world Mr. Spencer shows a remarkable aptitude for getting hold of facts and theories bearing upon his own doctrines, as is evinced in his recent discussions of Prof. Weismann's theories in the Contemporary Review. If, then, a critic declares Mr. Spencer has fallen behind the times, he may discover, if he makes inquiry of those who know what Mr. Spencer does, that it is easier to write misleading statements for a newspaper than to prove them when challenged. Perhaps it is expected of Mr. Spencer that he will turn aside from his work and prepare book reviews, to demonstrate his scholarship and his familiarity with questions of present importance in philosophy. But if he should have no better success in that way than his anonymous critic, it would scarcely be worth his while.

This critic is especially severe because, as he says, Mr. Spencer, in a passage quoted, "represents every operation of the mind as a recognition of a likeness or the recognition of an unlikeness. According to this, every operation of volition, every operation of going to sleep, and every other mental operation is but an act of recognition." The passage quoted by this able reviewer is this (Italics mine): "One division of an earlier work in this series of works—the Principles of Psychology—was devoted to showing that all *intellectual* operations are ultimately decomposable into recognitions of likeness and unlikeness." The writer who assumes to inform

his constituency so confidently of Mr. Spencer's paucity of knowledge and his general decrepitude does not seem to know that intellect, feeling, and will are three departments of mind, and that Mr. Spencer's statement is applied to one only. "Intellectual operations" are *not* all the operations of mind. What Mr. Spencer says he may be criticised for, not what his blind critic avers that he says. Yet this perversion with its comments occupies a long paragraph.

I have not space for further illustration of the heedless, dogmatic, crude, and false statements with which this worthless critique abounds; but the public will be exposed to its like so long as anonymity is the fashion in book reviews.

DANIEL GREENLEAF THOMPSON.

NEW YORK, *October* 30, 1893.

COLORED AUDITION.

Editor Popular Science Monthly:

DEAR SIR: Struck with M. Binet's paper, The Problem of Colored Audition, in The Popular Science Monthly for October, without questioning the facts, when consulting my own recollections I was unable to recall any one who possessed such curious powers.

Happening to meet to-day a young lady, the talk was about pleasant or unpleasant voices, such as are in use in ordinary conversation. Both of us commented on the voice of a person of our acquaintance, when the lady said: "So-and-so has a green voice. It always sounds green to me."

Without bringing M. Binet to the front, I questioned the lady in regard to this color comparison. I found that voices, intonations, and sounds had positive color effects on her mind. There was a gentleman whose voice was "red" to her. Then I asked her if she had read M. Binet, and she said she had no acquaintance with the article published by you, nor had she any conception that there was anything peculiar in her associating tones with colors. She said she always did it.

Respectfully, BARNET PHILLIPS.

BROOKLYN, *October* 6, 1893.

EDITOR'S TABLE.

SCIENCE AND CIVILIZATION.

THE close of the great Columbian Exposition at Chicago naturally suggests reflections as to its general significance and import. The Exposition was meant to furnish a conspectus, as it were, of what the art of man is able to accomplish toward the end of the nineteenth century; and, as a memorial of the civilization of to-day, its general catalogue would be to future ages a most important document. That the Exposition as a whole was a vast and overwhelming demonstration of the resources of modern life, no one can question. Until the riches of the world are gathered together in some such way we wholly fail to realize, and even when they have been so gathered together, we but imperfectly—very imperfectly indeed—realize what the achievements of our age have been. When the idea has, however, in some measure been brought home to us, we involuntarily ask, What has made our age to differ so much from past ages, when whole centuries would pass with very little change in the outward conditions of society? The answer lies on the surface: The modern world has found the key to real knowledge. In former ages a certain number of useful arts were discovered empirically and more or less fortuitously; to-day we have learned how to make discoveries, as it were, by rule. We regard Nature as a book, every leaf of which contains useful lessons, written sometimes in characters difficult to decipher, but always decipherable in the end if but proper pains be taken and proper methods pursued. In former ages men's minds were possessed by a number of absolute notions and *a priori* principles which they applied to the interpretation, or rather misinterpretation, of Nature; and as a consequence the discovery of truth lagged and languished. How greatly, for example, was the progress of astronomy retarded by the assumption that as the circle was a perfect figure, the planets must move in circles; that

because the earth was big to the eye and the sun small, the former must be the central orb and the latter the satellite; that mystic powers resided in certain numbers, and so on! To-day we come to Nature as simple questioners, not telling her what she must be, but asking her what she is, and what are her laws. A certain amount of knowledge, of course, we have gained, and this we use as capital for the accumulation of more; but even our best-established conclusions we hold subject to revision, at least as regards their theoretical expression. Even on the strength of experience we do not undertake to dictate as to what must be, for all experience is, we are aware, imperfect. We know in part, and therefore, when we are wise, we prophesy but in part. To revert for a moment to the science of astronomy, it may be said that we find there an unending series of lessons against *a priori* and absolute views. The planets are not perfect spheres; their orbits are not perfect circles, nor do they perfectly retain their form; their rates of movement are not uniform; their inclinations to the planes in which they move undergo constant changes. It might be supposed beforehand that they would all be developed on the same plan and in some regular order of gradation; but no, they increase in size from Mercury to the earth; then we have the moon (which is strictly a planet) of much inferior size; then Mars, much larger than the moon, but much smaller than the earth; then the fragmentary asteroids; then the giant Jupiter; then Saturn and Uranus successively smaller; and finally Neptune, larger than Uranus but smaller than Saturn. Again, as if to show a unique example of the way in which rings were thrown off from the original nebula, Saturn alone of all the planets is surrounded by rings which, in some way, managed to preserve their equilibrium as rings instead of being rolled together by gravitation into spheres. The solar system as a whole seems to speak to us in commanding tones and say, "When the laws and phenomena of Nature are concerned, don't assume to know what ought to be, but find out what is." On this line of the patient study of Nature all the victories of modern science, we might almost say of modern civilization, have been won.

Science is now of age and can take care of itself, but we have not to look back very far in the history of the world in order to come to the time when it had to ask the permission of Theology and so-called Philosophy for every step it took, and when frequently its progress was absolutely barred by some arbitrary mandate. In our own day even, what opprobrium has been heaped upon geologists like Lyell, and biologists like Darwin, simply because their conclusions threatened to disturb those in which the orthodox world, on wholly insufficient evidence, had been pleased to settle down! Henceforth Science will brook no dictation. She will not herself dictate to Nature, and she will suffer no arbitrary authority to dictate to her. What is scientifically true will be determined by evidence industriously gathered, carefully sifted, and cautiously interpreted; and the world will reap the benefit of the principles thus established in ever new additions to the comforts and refinements of life. Still more important, however, it may be hoped, will the progress of scientific thought prove in the intellectual and moral sphere. We want what we have never had as yet, but what the labors of that truly great philosopher Herbert Spencer have at least in part provided for us, a true science of life—that is to say, a scientific treatment of the duties of life and the means of happiness. But meanwhile much advantage will result from the gradual spread of scientific methods of thought—methods which incline to caution, to a careful scrutiny of causes and consequences, in the sphere of social action. Here-

tofore wisdom has been largely won through suffering; but we may hope that, with the wider establishment and recognition of sound principles of conduct, this will more and more cease to be the case. There does not seem any very good reason why men might not be taught to love right conduct just as they may be, and are, taught to prefer temperate and wholesome to intemperate and unwholesome eating and drinking. To tell the truth an advance of science is more wanted to-day in the sphere of conduct than in the mechanical arts. We could get on very well for the next quarter of a century without traveling any faster, or without any further cheapening of cotton goods; but every day we feel directly or indirectly the need of greater wisdom in the conduct of life; for daily we suffer either through our own errors or those of others. Ancient codes of ethics are very well—some of them at least—as far as they go; but it will be a good day for the world when it is universally recognized that the true canons of conduct are deducible by sound reasonings upon the facts of life and the relations of individuals, and that, so deduced, they have the highest authority that any moral code can possess.

A SCIENTIST, BUT NOT A PHILOSOPHER.

Among the papers contributed to the World's Congress of Religions was one by Sir William Dawson, of Montreal, entitled Religio Scientiæ (the Religion of Science). This eminent geologist never loses an opportunity of attacking the doctrine of evolution, and it is not surprising, therefore, that he should have done so on this occasion. No evidence has ever been afforded, however, that Sir William Dawson has taken proper pains to ascertain what evolution, as understood and taught by the leading believers in the doctrine, means. Speaking of man's moral nature, he says: "On this point a strange confusion, produced apparently by the doctrine of evolution, seems to have affected some scientific thinkers, who seek to read back moral ideas into the history of the world at a time when no mundane moral agent is known to have been in existence. They forget that it is no more immoral for a wolf to eat a lamb than for a lamb to eat grass." Now, it would be simply impossible for any one who had read even so brief a treatise as Spencer's Data of Ethics with any attention to have made such a remark. Let any one to whom that treatise is in the least familiar try to imagine Spencer forgetting that "it is no more immoral for a wolf to eat a lamb than for a lamb to eat grass"! A man with Sir William Dawson's reputation should really not commit himself in this way. Not only is there not one word in Spencer's writings to indicate that he thinks it immoral for a wolf to eat a lamb, but his whole method of treating the subject of the development of morality shows that he utterly repudiates such a view. What Spencer does attempt to do is to prove that the conduct we now call moral must be regarded as a development from conduct to which it is impossible to apply the term. He traces for us in the most careful manner every stage of the process; and if Sir William Dawson would undertake to point out where the line of succession fails, or, to express it otherwise, where the evolution of one stage from that immediately preceding it has been incorrectly assumed, he would then be grappling seriously with the ethical side of the doctrine of evolution. To do this, however, he would have to study Mr. Spencer's Principles of Ethics with careful attention, and this would probably not be agreeable to him. It would be easy to note other points in Sir William's address to which, from a scientific point of view, exception might be taken. Our purpose, however, on the present occasion is sufficiently served by showing that this really able geologist allows

himself to speak on philosophical subjects with altogether too slender an equipment of necessary knowledge.

LITERARY NOTICES.

The History and Theory of Money. By Sidney Sherwood, with Addresses by Dr. William Pepper and others. Philadelphia: J. B. Lippincott Company. Pp. 413. Price, $2.

The American people has heard more about the theory of money during the past summer than in a long time before. Much that has been said has been erroneous, and, unfortunately, the error has often been put forth so speciously that many of those who have not given the subject of finance serious study have mistaken the false for the true. During the early months of 1892, when the subject of money was also attracting considerable attention, a series of lectures was delivered in Philadelphia, under the auspices of the American Society for the Extension of University Teaching, and the patronage of the bankers of Philadelphia. These lectures were given by Dr. Sherwood, of the Wharton School of Finance and Economy, and, with certain supplementary matter, constitute the volume before us. The twelve lectures are evenly divided between history and theory; under the former head the principal topics are coinage, past fluctuations in the supply of the coin metals, the development of credit, the history of the Bank of England, and the history of American currency. The first lecture on theories is also historical, while the remaining five are devoted wholly to monetary theories now current. Dr. Sherwood affirms that the practical law of value of money is the law of demand and supply. Governments can, within narrow limits, make money more or less desirable and more or less plenty, thus affecting its value. He presents the argument both for and against a large volume of currency, and then sets forth certain important facts that bear upon this matter. Paper money he describes as a promise to pay. In treating of banks of various kinds he states that there is a growing tendency to divorce note-issue from the deposit and discount functions of banks; that the latter functions are constantly becoming more important, while there are tendencies both for and against the extension of the former. The eleventh lecture deals with the monetary question of greatest current interest—the Battle of the Standards, or monometallism *versus* bimetallism. Dr. Sherwood gives the arguments of both parties in the controversy, and states his conviction that bimetallism based on an agreement of the chief commercial nations would be advantageous, but attempted by one nation alone would be disastrous. France maintained it only so long as certain accidental conditions existed. The policy of the United States under the Sherman law is not bimetallism. The subject of the closing lecture—monetary panics—is also a timely one. The lecturer points out seven causes of panics, and states the measures taken by financial institutions for allaying them. Each of the lectures was followed by a discussion, which is reported. Appended to the volume are a syllabus of the lectures and a list of books for reading. Addresses made by Dr. William Pepper, Mr. William H. Rhawn, and others, at the opening and closing of the course, are also included.

Brief Guide to the Commoner Butterflies of the Northern United States and Canada. By Samuel Hubbard Scudder. New York: Henry Holt & Co. Pp. 206. Price, $1.25.

The Life of a Butterfly. By S. H. Scudder. New York: Henry Holt & Co. Pp. 186. Price, $1.

The former of these small volumes is a manual for amateur collectors. The author has aimed to guard against alarming the beginner by its size, and to give quite full life-histories of the butterflies that are included in it. It is described further in his own words as follows: "I have accordingly selected the butterflies—less than a hundred of them—which would almost surely be met with by any industrious collector in the course of a year's or two years' work in the more populous Northern States and in Canada, and have here treated them as if they were the only ones found there. I have omitted many species which are common enough in certain restricted localities (such, for instance, as our White Mountain butterfly), and included only those which are common over wide areas. As the earlier stages of these insects are just as varied, as inter-

esting, and as important as the perfect stage, descriptions are given of these under the guidance of the same principle." The work opens with a short introduction to the general study of butterflies, which is followed by keys to the various groups, based respectively on the perfect butterfly, the caterpillar, and the chrysalis. The body of the work consists of concise descriptions arranged systematically, each comprising first a description of the butterfly, the caterpillar, and the chrysalis, then some account of the eggs and habits of the species. An appendix furnishes instructions for collecting, rearing, preserving, and studying, with cuts of apparatus.

In The Life of a Butterfly, Mr. Scudder has described one of the most conspicuous American butterflies—the large orange and black milkweed butterfly—and at the same time he has, by introducing comparisons, given some account of the lives of the other members of its tribe. The several habits of the chosen type are also used to illustrate such general scientific topics as the struggle for existence, mimicry, distribution, classification, etc. Four plates, showing the type insect and its important parts, are given.

General Greene. By Francis Vinton Greene. Great Commanders Series. New York: D. Appleton & Co. Pp. 332. Price, $1.50.

Some splendid fighters have come of Quaker stock, and Nathanael Greene was a notable one of these. His comparatively short life was a most valuable one to this country, and to-day his statue stands with that of Roger Williams to represent Rhode Island in the Capitol at Washington. His life up to thirty-three years of age was uneventful. Then the Revolution broke out, and the Assembly of his colony elected him brigadier general to command the Rhode Island militia. The choice was amply justified by Greene's career, first as a thorough organizer in camp near Boston, then as the friend and trusted subordinate of Washington in the operations about New York and Philadelphia, as quartermaster general, and most of all as the strategist, ever active and vigilant, who manœuvred the British out of the Carolinas. The volume before us gives a vivid and detailed account of his part in the struggle for independence. The descriptions of battles are clear and precise and all important ones are illustrated with maps. An engraving from the portrait of Greene by Charles Wilson Peale forms the frontispiece of the volume.

Geology. By A. J. Jukes-Browne. New York: Macmillan & Co. Pp. 248. Price, $1.

This is one of the volumes of Whittaker's Library of Popular Science, and its simple style amply justifies its appearance in such a series. It is a small book, containing only the information that would be desired by an intelligent person who did not care to make a study of the subject. Its twenty-one short chapters are divided into three groups: the first telling how rocks are made, and what they are made of; the second telling how the rocks were brought into the positions they now occupy; and the last describing the rocks of different ages, and the fossils which serve to identify them There are ninety-four illustrations.

A History of Ireland in the Eighteenth Century. By W. E. H. Lecky. New York: D. Appleton & Co. Five volumes. Price, $5.

In this work Mr. Lecky develops a profoundly interesting chronicle. Not only does it present much that is novel to those whose ideas of the subject have filtered through English media, but it reveals the forces which have aided in the evolution of Irish character.

The typical traits of the Irish are often carelessly ascribed to racial differences. The influence of the Celtic element is not easily traced and is apt to be overestimated. What are termed distinctively Irish evils characterize chiefly the counties settled by Englishmen. Religion has been a more potent factor in modification, while the climate and situation of the country have had an important share in the formative process.

The suppression of her industries contributed largely to the downfall of the nation. The policy of England, however, was essentially the same toward Scotland and America, but Ireland was for various causes more completely in her grasp. It is difficult to read unmoved the struggles of this unfor-

tunate people. Not only was their land confiscated, all commerce and manufacture legally restricted, their religion made a crime, but premiums were put upon bribery and treachery. The feeling in England was carried to such an extreme that petitions were presented to prohibit Irishmen from catching herrings, because they might forestall English markets! According to Burke, "the Irish were treated as a race of savages who were a disgrace to human nature itself," and even the poet Spenser advocated their subjection by systematic starvation. The object of English rule seemed at first to wipe out the Irish race rather than their religion; later, it assumed the phase of a war of creeds.

It is shown by Mr. Lecky that the Irish were naturally tolerant. They harbored Quakers and Huguenots, sheltered Protestant clergymen, and did not indulge in the burning of witches. The English, on the contrary, were relentless persecutors, and although there was no summary destruction of Papists in Ireland, such as there had been of Protestants in Spain, yet the results of legislation were further reaching and more pernicious. "The law did not suppose any such person to exist as an Irish Roman Catholic." Every office and profession was closed to him; it was even a penal offense to pick up the crumbs of learning as an usher in a school. Land he could not buy, nor own a horse over the value of five pounds. He could not appoint a guardian for his own child, and if he married a Protestant, the ceremony was null and the priest who performed it could be hanged. The degradation of the Irish by this penal code was unparalleled, since it affected not a minority but three fourths of the population and was in force nearly a century. A perusal of the laws in the light of the present day is enough to make one blush for English ancestry. Judged even by the intolerance of the age, they were excessive and short-sighted, and form an indelible blot upon English government. The disputed character of Irish history necessitates frequent reference to original materials; these include the correspondence and records of the English and Irish Governments and a vast number of private papers and letters. The reader is thus enabled to judge the truth for himself, and, far from finding the narrative a dull one, is almost persuaded that he is in the current of events.

The limits of this work do not correspond to those of the History of England, previously issued. They include the rebellion of 1798, the legislative union of 1800, and the events of the two succeeding years, as properly belonging to the same epoch.

The Physiology of the Senses. By John Gray McKendrick, M. D., and William Snodgrass, M. B. New York: Charles Scribner's Sons. Pp. 318. Price, $1.50 net.

It is the aim of this book, which is one of the series issued under the name of University Extension Manuals, to give a succinct account of the functions of the organs of sense in man and the higher animals. The authors have refrained from discussing with fullness of detail either the comparative physiology of the senses or the numerous interesting questions of a psychological character that are connected with the study of the sensory mechanisms. The volume has been written so as to be readily understood even by those who have not made physiology a special subject of study. Some comparatively simple experiments have been given, by which the reader may test certain of the statements for himself. The last chapter is of a speculative character, being an attempt to elucidate the nature of the physiological basis of sensation. The volume is illustrated with one hundred and twenty-seven figures.

British Forest Trees and their Sylvicultural Characteristics and Treatment. By John Nisbet, D. Œc. New York: Macmillan & Co. Pp. 352. Price, $2.50.

One more evidence of the growing attention that is being paid to forestry is furnished by the appearance of this work. It is devoted to what may be called the larger considerations of sylviculture, such as the choice of kinds of trees for plantations, the mixing of different kinds, so that they will help and protect each other, the proper density of forests, underplanting, etc., details of such matters as sowing, planting, and tending being omitted. The greater part of the volume is devoted to special considerations regarding the growth of individual

species of British forest trees. Among those classed as minor species not usually forming pure forests in Britain are five conifers introduced from North America. Something is told also in regard to the yew, juniper, hazel, alder, buckthorn, and hawthorn among useful shrubs.

Lecture Notes on Theoretical Chemistry. By F. G. Wiechmann. New York: John Wiley & Sons. Pp. 225.

A large body of notes, corresponding to an extended course of lectures, is given in this book. Many of the facts, laws, and processes which it includes are stated with much fullness and are accompanied with illustrative examples. As indicated by the title, the work is confined to theoretical chemistry, and much of the history of chemical theory is included in it. A chapter is given to solutions in which the recent work on that subject finds a place. Thermo-chemistry receives due attention, and there are short chapters on photo-chemistry and electro-chemistry. Considerable prominence has been given to stoichiometry, but for problems in this subject students are referred to special manuals. The author is instructor in chemical physics and chemical philosophy at the School of Mines, Columbia College.

The Birth and Development of Ornament. By F. Edward Hulme, F. L. S., F. S. A. New York: Macmillan & Co., 1893. Pp. 340. Price, $1.50.

This book is an attempt to put into small compass and cheap form a general view of the origin and growth of the use of ornament. The opening paragraph follows: "The Birth of Ornament! Countless centuries before man appeared upon the earth, the Creator of the universe had gazed upon the work of his hands, and declared that all had reached his lofty ideal." Certainly the author can not be accused of too modern a starting point, and he further on puts this beyond question. "Hence we claim for our subject nothing short of infinite antiquity, nothing less than divine authority." The first chapter deals with the value of a knowledge of past ornamentation, the study of principles, and various other general matters. Chapter II really opens the subject, with a consideration of Egyptian, Assyrian, Babylonian, and Phœnician art. Chapter III deals with Greek and Roman art Chapter IV, division of the Roman Empire: Byzantine, Romanesque, and Early English Art; Chapter V, Causes of the Decay of Gothic Art, and the Renaissance; and Chapter VI, The Art of Islam, Persian, Indian, Chinese, Japanese, Mexican, Peruvian, and, finally, Art among the North American Indians and the Primitive Savages. The work seems to be the result of a large amount of labor and time. It is very well illustrated with examples from the various periods, and abounds in quotations from such authorities as Sir Joshua Reynolds, Guizot, Ruskin, and Wilkinson. It contains a useful index.

A Dictionary of Applied Chemistry. By T. E. Thorpe, D. Sc., F. R. S., assisted by Eminent Contributors. In Three Volumes. Vol. III. O–Z. London and New York: Longmans, Green & Co. Pp. 1058. Price, $20.

We congratulate the editor and the publishers upon the completion of this valuable work. So many subjects requiring extended treatment fall within the latter part of the alphabet that the concluding volume has grown far beyond the size of the other two, and its price has been increased by five dollars. The article on Sulphuric Acid occupies sixty pages, and treats fully each detail of the process of manufacture. Sixteen cuts, showing brimstone burners, steam jet pipes, Gay-Lussac and Glover towers, and other apparatus are given. Another subject demanding large space is the making of sodium carbonate, which is described with like fullness. The making of other compounds of sodium and the extraction of the metal itself also receive due attention. Under the head of Silver the extraction of that metal is described, and under Zinc we find the methods of extracting the metal and the composition of its alloys. The article on Water, contributed by Prof. Percy F. Frankland, is characterized by a large number of results of analyses of waters from sources of various geological characters and from various local supplies—mainly in the British Isles. The composition of many saline and other mineral waters is given also. Modes of purifying water for drinking and for industrial purposes are described, together with a process of chemical analysis. Prof. Frankland also gives a special section on the bacteriol-

ogy of water, and refers inquirers to half a page of authorities. Among the organic substances treated in this volume are the oils, paraffin, petroleum, starch, and sugar. The Vegeto-alkaloids, grouped under this head, are also found here. The Triphenylmethane Coloring Matters are another important group of organic substances treated in the present volume, the author of the article being Prof. Otto N. Witt, of Berlin. Alfred H. Allen, author of the Commercial Organic Analysis, contributes the article on Fixed Oils and Fats; Prof. W. A. Tilden, those on the Essential Oils, Terpenes, and Resin; the one on Sugar is by Messrs. J. A. R. and B. E. R. Newlands; that on Russian Petroleum is by Boverton Redwood; and that on American Petroleum by Prof. S. P. Sadtler, of the University of Pennsylvania. Among the more purely scientific articles are those on Specific Gravity, Solution, and Spectrum Analysis; while others whose technological character are more marked are Paper, Pottery and Porcelain (by William Burton, Esq., of the Wedgwood Works), Photography, Soap, Tea, and Wine. The contributions of the editor (unsigned articles) are many and important. When so much chemical knowledge is spread before us, perhaps we ought not to expect Prof. Thorpe to know what Americans mean by saleratus, or even the current spelling of the word (p. 364); and it is still less material that he allows his contributor, John Heron, Esq., to annex Long Island to New Jersey (p. 579).

A Guide to Stereochemistry. With an Appendix: Models for Use in teaching Organic Chemistry. By Arnold Eiloart, Ph. D., B. Sc. New York: Alexander Wilson, 26 Delancey Street, Agent. Price, $1 net; postage free.

The scope and purpose of this book may be best indicated by the following quotation from the author's preface:

"Although no new branch of chemistry is found more interesting by chemists and students than that which treats of the arrangement of atoms in space, so that lectures on the subject are everywhere welcome, yet it has been difficult to give guidance and permanence to this interest. . . . It seemed desirable in attempting to supply such a book to make it as compact as possible without stripping the subject of the charm so natural to it. In this Guide, therefore, established facts have been promptly accepted as such. . . . Living issues appropriate the pages thus gained, so that more than the usual proportion of space is occupied by the later and more daring developments of stereochemistry; the theories concerning the space-relations of nitrogen are a case in point. At the same time especial care has been taken to notice the criticisms of those hostile to such innovations."

It should be added that this work, while it may be used as a text-book by students, will also be read as a critical and historical review of the subject.

The American Book Company adds Shakespeare's *Merchant of Venice* to its series of English Classics for Schools. An account of the sources whence the play was derived, a notice of the occasion on which it was written, suggesting that it was designed to take advantage of current sensational events, and an analysis, are given in the introduction.

The *Letters from Queensland* (Australia), reprinted from the special correspondence of the London Times by Macmillan & Co., contains, besides sketches of travel and scenery and incidental observations of Chinese and Kanaka labor, valuable information and statistics about the sugar industry and mineral wealth of the colony, cattle and sheep raising, and a political chapter on the Separation Question, or the question of the division of the colony by the separation of North Queensland.

Moses or Darwin? A School Problem for all Friends of Truth and Progress, is the title of three papers on Evolution and Darwinianism which were originally delivered as lectures by the author, Dr. *Arnold Dodel*, at Zurich and St. Gall, Switzerland. Their immediate purpose was to direct the attention of the public "to the calamitous gulf lying between the higher and the common schools"—which he further describes by the words "Truth for the few" (higher school pupils, to whom the scientific doctrines of evolution are taught) and "Errors for the many" (lower school pupils, who are taught "the Mosaic myth"). The translator and American editor, Frederick W. Dodel, furnishes a preface, in which is a disquisition on School

Reform in the West, the burden of which is the installation of science and the elimination of all religious teaching in all the schools. (The Commonwealth Company, Boston.)

The character of the Essays included by Mr. *Henry Smith* under the general title of *Religion of the Brain* is indicated by the frontispiece, which pictures an ivy-grown tree with the motto, "The Ivy has nearly killed the tree, Theology has all but destroyed religion. Science will kill Theology, then Religion will revive." Submitting to theological teachings during half of his life, he professes to have found them barren. Then he turned to science, and, while it took from him the hope of heaven, it taught him how to make this life happy; it took from him theology, and gave him natural religion. He sets forth in this book how he accepts the teaching of science and declines that of theology. (Watts & Co., London. Price, 2*s.* 6*d.*)

Karl Heinzen, the author of a volume on *The Rights of Women and the Sexual Relations*, published by Benjamin R. Tucker, Boston, is described by Karl Schmemann, editor of this present edition, as "one of the most enlightened and humanitarian spirits of our time, whose libertarian and reformatory labors were not limited to his German fatherland and our republic, but extended to the entire civilized world by their unique and masterful many-sidedness." The author advocates, with great freedom and little reserve, the complete emancipation and independence of woman, with "liberty to choose her companion and liberty to change."

Instead of a Book is published by the author, *Benjamin R. Tucker*, because, he says, he was "too busy to write one"; that is, to give orderly arrangement, finish, symmetry, and due subordination to his thoughts on the cause he champions. He has been for twelve years editor of a journal called Liberty, in which he has expounded the principles of "Philosophical Anarchism." Pending the arrival of the man having time, means, and ability to produce the book that is desired in maintenance of this cause, he has put forth "as a makeshift" a partial collection of his writings for his journal. The volume opens with a paper on State Socialism and Anarchism, which represents, in a way, a summary of the entire scope of the work. In the sections, or groups of essays following this, the fundamental principles of human association (as he regards them) are dealt with; applied to the two great economic factors, money and land; the "authoritarian social principles that go counter to them" are dealt with; and the methods by which the championed principles can be realized are discussed. Other articles, less subject to classification, follow. While the work is highly objectionable from the conservative point of view, it is not at all wanting in vigor and earnestness. ($1.)

In preparing his *Standard Arithmetic* for schools and academies, President *William J. Milne* of the Normal College at Albany, has aimed to secure together in the student skill in numerical computations and a proper understanding of the reasons for the steps in the explanation of processes and the solution of problems. Either can be acquired without the other, but the student will not then be a full arithmetician, while with both he is qualified for any work. The book, therefore, contains examples to promote accuracy and rapidity, and exercises to train the analytical powers and develop the reasoning faculties. Business methods of computation are preferred to the processes of the schools. (American Book Company.)

Mr. *R. Lachlan's Elementary Treatise on Modern Pure Geometry*, and the *Elementary Treatise on Pure Geometry* of Mr. J. W. Russell, cover substantially the same ground in very similar manners. Pure geometry is defined in the new regulations for the Cambridge Tripos as "namely, Euclid; simple properties of lines and circles; inversion; the elementary properties of conic sections treated geometrically, not excluding the method of projections; reciprocation; harmonic properties; curvature." Mr. Lachlan has brought together in his treatise all the important propositions—bearing on the simple properties of lines and circles—that might fairly be considered within the limits of this regulation; and has at the same time endeavored to treat every branch of the subject as completely as possible, in order to attract a larger number of students to the science. Mr. Russell has attempted in his treatise to bring together all the well-known theorems and examples connected with harmonies, anharmonies, involution, projection (including

homology), and reciprocation. In order to avoid the difficulty of framing a general geometrical theory of imaginary points and lines, the principle of continuity is appealed to. The properties of circular points and circular lines are then discussed, and applied to the theory of the foci of conics. This work is also well furnished with examples. (Macmillan & Co. Price, $4.25 and $2.60.)

The *Primary Lessons* and the *Advanced Lessons in Human Physiology*, by Prof. *Oliver P. Jenkins*, are successive volumes in the Indiana State series of common-school text-books. The author insists that the books be used only as a guide to the study of the human body, and not as the object to be studied. "If this or any other elementary book in physiology is used simply as a book to be learned and recited, the time spent on it is worse than wasted." The author shows that many parts of the body can be put directly under study and their operations carefully observed and analyzed, while the lower animals can furnish the rest of the illustrations. The body should also be observed in action. Charts and drawings have their place in the teaching, but "they should come after the objects and never before, and certainly should not stand for them." In the second book of the series—*Advanced Lessons*—directions are introduced for the practical demonstration of many anatomical and physiological facts. Recognizing the change that has come in recent years over the tone and spirit of physiological thought and discussion, the author has endeavored to infuse enough of this spirit into his work "to introduce even the young student into its influence." (Indiana School-book Company, Indianapolis.)

A *Student's Manual of a Laboratory Course in Physical Measurements*, by *Wallace Clement Sabine*, is a guide to experiments. It was primarily written for one of the Harvard courses in physics, and the experiments detailed in it are based upon those performed in that course. It has been given the form of an abstract of the daily lectures preceding the laboratory work and describing the experiments to be performed, and is intentionally condensed. Efforts are made to explain all the corrections to be applied, and to call attention to all the precautions which should be taken in the accurate and proper performance of the experiments. On the other hand, in the majority of cases, the description is purposely not such as will admit of a mechanical and unintelligent interpretation. (Boston: Ginn & Co.)

The second part of *Jane H. Newell's Reader in Botany* contains selections for reading, adapted from well-known authors, on flower and fruit. In it Christian Conrad Sprengel is represented by passages on Cross-Fertilization and Fertilization of Tropæolum, Darwin in Cross-Fertilization, Heterostyled Flowers, and the Habits of Insects in Relation to Flowers, writers in the German *Pflanzenleben* in The Protection of Pollen, The Dissemination of Pollen by the Wind, and The Color of Flowers as a Means of attracting Insects; Wallace in Attractive and Protective Colors of Fruits; Gray in Fertilization of Orchids; Grant Allen and Byron D. Halsted in Weeds; F. L. Sargent in The Common Dandelion; Sir John Lubbock in Habits of Insects in Relation to Flowers; Miss Buckley in Epochs in the History of Botany; and four papers have no names attached. (Boston: Ginn & Co.)

The Orum System of Voice Education, for reading and conversation, recitation, dramatic expression, and Bible reading, by Julia A. Orum, is based on the system of James Fennell, as transmitted through his pupil, L. G. White, and Mr. White's pupil, James B. Roberts. The author has made its illustration and establishment her special work for sixteen years. The book is a transcription of her method of instruction in schools and classes which include children and men and women of various vocations. It is based upon physiological principles, and begins with the elucidation of the elemental functions of the body in the expression of sentences. (Published by the author at Philadelphia.)

The *Manual of Current Shorthand*—orthographic and phonetic—of Mr. *Henry Sweet* is intended to supply the want of a system of writing shorter and more compact than longhand, and at the same time not less distinct and legible. None of the systems most in use at the present time, the author affirms, fully meet these requirements, because they sacrifice efficiency to brevity. The present system is on a script basis instead of a geometrical one, like Pitman's—that is, is formed on its model of ordinary longhand, reduced

to its simplest elements; it provides for the vowels, and is on an alphabetic and syllabic basis. (Macmillan & Co., $1.25.)

The seventeenth monograph of the Geological Survey is *The Flora of the Dakota Group*, a work on fossil botany by the late *Leo Lesquereux* (Geological Survey, $1.10). The specimens from which the descriptions in this work were written are mostly in the Museum of Comparative Zoölogy at Cambridge, the museum of the University of Kansas, and the private cabinet of Mr. R. D. Lacoe, of Pittston, Pa. This was the last production of its author, and the chief events of his life are appropriately set forth in the editor's preface.

A monograph on the *Gasteropoda and Cephalopoda of the Raritan Clays and Greensand Marls of New Jersey*, by *Robert Parr Whitfield*, is the eighteenth in the series of the Geological Survey, and forms also a part of the report on the Survey of the State of New Jersey. The material for this report was very meager, the gasteropods being represented in the several formations only by casts and the cephalopods largely by fragments. Fifty plates, each bearing from one to thirty figures, illustrate the text.

The United States Geological Survey has issued *A Dakota-English Dictionary*, by *Stephen Return Riggs*, a quarto volume of 665 pages. The author, who died in 1883, was a student of the language for missionary use for over thirty years, having prepared a grammar and dictionary that was published by the Smithsonian Institution in 1852. The present volume has been edited by James Owen Dorsey.

In the *Report of the Commissioner of Education for 1889-'90* it is shown that the property used for common schools had reached the value of $350,000,000, an average increase of $10,000,000 a year since 1870. In the same period the school attendance in the South Atlantic States had risen from six to twenty-two per cent of the whole population, and in the South Central States from seven and a half to twenty-three and a half per cent. The enrollment for the whole country is twenty-three per cent. This is a better showing than that of any other nation except Saxony. But many European states have a much longer yearly session than we have. Here, says the commissioner, is the place to show improvement in future years. Among the subjects on which special reports are presented are the educational congresses held in Paris in 1889, education in Scotland, the higher schools of Prussia and the school conference of 1890, temperance instruction, and the curricula of professional schools. Numerous other topics receive attention also, and there are the usual statistics.

PUBLICATIONS RECEIVED.

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Arnold, Thomas K. First and Second Latin Book. Pp. 416.—Latin Prose Composition. American Book Company. Pp. 415. $1 each.

Bardeen, C. W. History of Educational Journalism in the State of New York. Syracuse, N. Y.: C. W. Bardeen. Pp. 45. 10 cents.

Bedell, rederick, and Crehore, A. C. Alternating Currents. New York: W. J. Johnston Co., limited. Pp. 325.

Benedict, James E. West African Crustaceans. Washington: Smithsonian Institution. Pp. 10.

Bennet, C. W. History of the Philosophy of Pedagogics. Syracuse, N. Y.: C. W. Bardeen. Pp. 43. 50 cents.

Bowen Cooke. C. J. British Locomotives. New York: Macmillan & Co. Pp. 376. $3.

Bradford, E. G. Search Lights and Guide Lines (Man and Nature, etc.). New York: Fowler & Wells Co. Pp. 103.

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Carter, Oscar, C. S. Artesian Wells. Pp. 9.

Carus, Dr. Paul. Our Need of Philosophy. Pp. 14.—The Religion of Science. Pp. 103. 25 cents.

Cox, Frank P. Continuous-current Dynamos and Motors. New York: W. J. Johnston Co., limited. Pp. 271.

Dall, William Healey. A Subtropical Miocene Fauna in Arctic Siberia. United States National Museum. Pp. 10, with Plate.

Davy, R. B., M. D., Olema, Cal. Evolution and Involution of the Special Senses. Pp. 10.

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Drake, N. F., and Thompson, R. A. Report on the Colorado Coal Field of Texas. Austin. Pp. 136, with Maps.

Fontaine, William M. Fossil Plants from the Trinity Division, Texas. United States National Museum. Pp. 26, with Plates.

Gould, George M., M. D., Philadelphia. The Duty of the Community to Medical Science. Pp. 12.—A Temporary Change in the Axis of Astigmatism. P. 1.—The Meaning and the Method of Life, reviewed by Josiah Roice. Pp. 7.—The Medical Press. Pp. 12.—The Spelling of some Medical Words. Pp. 8.—The Pernicious Influence of Albinism on the Eye. Pp. 10.—A New Illustrated Dictionary of Medicine, Biology, and Collateral Sciences. Specimen pages.

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Jenner, Sir William. Lectures and Essays on Fevers and Diphtheria, 1849 to 1879. New York: Macmillan & Co. Pp. 581.

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POPULAR MISCELLANY.

The World's Congress on Geology.—This auxiliary of the Columbian Exposition occupied the week August 21st to 26th, having a large attendance of geologists of the United States and Canada, with a few from other countries, though many papers were sent to the Congress by foreign geologists. The sessions were held only in the forenoons, leaving the afternoons for attending the World's Fair. Forty papers were presented before the Congress, of which thirteen were by women who are teachers and special students of geology, three of these being from

England, one from Belfast, Ireland, three from Massachusetts, two from Ohio, two from Illinois, and one each from Iowa and Colorado. Of the twenty-seven papers by professional geologists, twelve were from the United States and three from Canada, the twelve others being as follows: from Brazil, two; Venezuela, one; England, Scotland, and Germany, each two; and Sweden, Norway, and Switzerland, each one. Besides the formal papers, interesting discussions followed, and the programmes for three of the days ended with questions for special discussion, these being, Are there any natural geological divisions of world-wide extent? What are the principles and criteria to be observed in the restoration of ancient geographic outlines? and similarly, What are the principles and criteria to be observed in the correlation of glacial formations in opposite hemispheres? Among the geologists present at this Congress were Prof. Dr. Groth, of Munich; Mr. Hjalmar Lundbohm, of Stockholm; Dr. A. R. C. Selwyn, Director of the Geological Survey of Canada; the venerable Prof. James Hall, whose work in geology began sixty years ago; Profs. Le Conte, Chamberlin, Salisbury, Lindahl, Walcott, H. S. and G. H. Williams, N. H. Winchell, G. F. Wright, and many others from the United States.

Subdivisions or Unity of the Glacial Period.—The final day of the World's Congress on Geology was devoted to papers on the Glacial period, of which eight were presented. Brief notes of these papers and of the ensuing discussions will be of popular interest, as they all were specially directed to the recently much debated question whether the ice age comprised two or several glacial epochs, separated by warm intervals, as has been urged by Croll, Geikie, Wahnschaffe, Penck, De Geer, Chamberlin, McGee, and others, or was a single and continuous period of glaciation, as maintained by Dana, Wright, Upham, Lamplugh, Kendall, Falsan, Holst, Nikitin, and others.

The first paper of this series was by Prof. James Geikie, of Scotland. This distinguished glacialist concludes, from his observations in Great Britain and their correlation with the northern drift-covered portion of continental Europe, that no less than five distinct glacial epochs are recognizable there, separated by long times of interglacial temperate climate. These alternations are held to be in accord with Dr. James Croll's astronomic theory of the causes of the Ice age, affording indeed a demonstration of the truth of that theory.

Mr. Hjalmar Lundbohm, of Sweden, giving the results of his own studies and of the more extended observations of Baron De Geer in that country, thought that good evidence is found for two epochs of ice accumulation and drift deposition. During the first glaciation the Scandinavian ice-sheet flowed outward over the northwestern half of Russia and the northern half of Germany, while southwestward it covered the basin of the North Sea and was confluent with the British ice. The later glaciation, in which a great ice-lobe stretched south and southwest over the basin of the Baltic Sea, formed conspicuous moraines in Finland, northern Germany, and southern Sweden. Since the retreat of this ice-sheet Scandinavia has been differentially uplifted to a maximum amount of about one thousand feet in the center of the peninsula, and the Baltic Sea has been alternately open to the ocean and closed from it, so that for some time it was a fresh-water lake.

Mr. Andrew M. Hansen, of Norway, also declared in favor of two glacial epochs, each of them including two or more stages of ice advance and retreat. The glacial drift of Norway, however, was described as affording little testimony of an interglacial epoch, which this author accepts from its stratified deposits underlain and overlain by till in other parts of Europe.

Dr. Albrecht Heim, of Switzerland, from the glacial drift with intercalated beds containing lignite coal and plentiful plant remains in valleys of the Alps, confidently asserted that the glaciers must three times have advanced far beyond their present limits. The second advance was the farthest, and was doubtless contemporaneous with the maximum extension of the ice-sheets of Scandinavia and Great Britain.

Dr. Robert Bell spoke of the glaciation of Canada, which was wholly enveloped by the North American ice-sheet, excepting a tract west of the lower Mackenzie Valley and perhaps a narrow area adjoining the east

side of the Rocky Mountains in Alberta. The stratified beds, some of them fossiliferous, and others containing layers of lignite, which are found in Canada between deposits of till, may probably be explained by moderate advances of the ice-sheet interrupting its general recession, not so prolonged nor important as to be called interglacial epochs.

Prof. T. C. Chamberlin reviewed the history of the Ice age in the United States, concluding that it has probably a threefold division. Two long glacial epochs had preceded the chief time of deposition of the loess, which was followed by the principal interglacial epoch with retreat of the ice border perhaps generally to the northern line of the United States. The last great ice advance and stages of its retreat were attended by the formation of the remarkable marginal moraines, ten to twenty in order from south to north, which have been mapped across the northern United States and portions of Canada, while others doubtless remain to be traced in regions farther north.

Mr. Warren Upham noted the uniqueness of the climatic conditions of the Ice age, and the absence of glacial periods from the far longer Tertiary and Mesozoic eras. So exceptional climate during the Quaternary era must have resulted from very unusual causes, which could not be astronomic, for in that case records of frequently recurring general glaciation would be found in the long preceding eras. Great uplifts of glaciated countries to such altitude that they received snowfall instead of rain during all the year are regarded as the cause of the ice accumulation; but the vast weight of the ice-sheets finally depressed the land, bringing on a warm climate by which the ice was at last rapidly melted away. Only one epoch of glaciation, with fluctuating advance and recession of the ice, is held to be a sufficient explanation for the observed glacial phenomena of both North America and Europe; and the Glacial period in each of these continents appears to have ended only some six thousand to ten thousand years ago.

Mr. Frank Leverett described the diverse deposits of the older drift in northwestern Illinois, showing on a map of that State the courses of the glacial boundary and retreatal moraines which he has traced. Comparison of the depths of stream erosion in the older and newer drift indicates that their times of formation were divided by a much longer interval than the time from the end of the Ice age until now.

In the discussion following these papers, Prof. G. F. Wright spoke of the rock gorges eroded by the Delaware, Susquehanna, and upper Ohio Rivers below the highest drift-gravel terraces. This erosion has been referred to an interglacial epoch, but he finds evidence that it was preglacial, and that the valleys were filled with the early drift gravels from their present bottoms to the level of the high terraces. The general parallelism of the drift boundary and the successive retreatal moraines is thought to imply the formation of all the drift during a single epoch.

Prof. R. D. Salisbury cited the much deeper oxidation and leaching of the older than of the newer drift as proof of their widely different ages, separated by a long interval of ice departure and mild climate.

Major C. E. Dutton objected to the extension of theories beyond the warrant of facts observed. He thought it too early at the present stage of investigations to decide the causes of the Ice age; but he doubts the astronomic theory, and looks rather to geographic conditions.

Lack of time prevented the consideration of the subject assigned for special discussion, on the correlation of glacial formations in opposite hemispheres, which, however, had been more or less touched upon by several of the papers. The prevailing view seemed to be that the glaciations of Europe and America were nearly or quite at the same time, and that there was a close agreement in the sequence of events constituting the Ice age on both continents.

The World's Fair Model Library.—The model library of five thousand volumes shown by the American Library Association at the World's Fair is to be sent to the Bureau of Education at Washington for use and exhibition. This library marks a noteworthy step in advance in the choosing of books—in each department the selection was committed to an authority in his field. In the sections of electricity, photography, general political economy, and American government, lists were printed, each title being followed by a note of description and appraisal

from an eminent teacher. This method, were it applied to the whole working literature of education, would place the judgments of the best teachers at the service of all the people. Of the catalogue of this library the Bureau of Education is printing twenty thousand copies.

Thickness of Oil Films.—From experiments made in the Baltic Sea off Greifswald, Prof. Oberbeck, of the University of Greifswald, has found that the surface of water calmed by one litre of rape-seed oil or machine oil oscillates around nineteen thousand square metres, indicating that the thickness of the film is about one twenty-thousandth of a millimetre. The oil doubtless extends also in an imperceptible film outside of the circle of calm, whence the average thickness of this inner layer is probably even less. The author has made skillfully devised series of laboratory experiments to determine still more precisely the minimum thickness of a perceptible film, and found it to be two millionths of a millimetre. This is the same thickness as that which Lord Rayleigh found adequate to arrest the movements of camphor. Mr. Röntgen has also found that the vapor of ether striking upon oil scatters it till it is reduced to the same thinness. According to Herr Oberbeck, a film six times thinner is still coherent. If the quantity of oil is gradually increased the pellicle becomes more and more resistant, and of uniform thickness. When it reaches eighteen millionths of a millimetre, the oil collects in droplets which rise above the rest of the surface; and the film does not become uniform till enough oil has been poured on to equal the entire thickness of the droplets.

Advances in the Dairy Industry.—At the Dairy Building at the World's Fair there were daily demonstrations of the best modern practice in butter and cheese making. Prof. S. M. Babcock, of the University of Wisconsin, the chemist in charge, as part of his apparatus, employed the milk tester invented by him in 1890. This tester is used by adding to milk an equal quantity of sulphuric acid of 1·82 or 1·83 specific gravity. The mixture is poured into a series of glass bottles, each drawn out at the neck as a narrow and calibrated tube; the bottles, laid in an inclined position on a frame, are rotated 700 to 1,200 times per minute; the sulphuric acid separates the fat, and this fat, by centrifugal motion, is sent up into the calibrated tubes, where it is easily read off. This test places the dairy industry upon a business footing, and not only enables the proprietor of a butter or cheese factory justly to appraise the milk he buys, but also decides for the dairyman which of his cows is most profitable and which should be sent to the butcher. The importance of this simple and ready test is evident when we learn that in Wisconsin alone there are 1,700 butter and cheese factories. The Babcock tester is manufactured by some twenty firms in the United States, and by a firm in England and a firm in Germany. Due as it was to the experiments of a servant of a State, the device has not been patented. To this fact is in part due the wide sale of the tester; it is so simply manufactured that no costly patterns and plant are needed for its production; at retail the price is but eight to twelve dollars, according to size. To his forerunners in the task of fat testing Prof. Babcock declares his indebtedness. Mr. Short, of the University of Wisconsin, had invented an apparatus in which milk fat was saponified and driven forth by centrifugal motion; Prof. Patrick, of Iowa, employed, in a tester of his design, an acid instead of an alkaline combination. Uniting an idea from each of these devices, Prof. Babcock hit upon success.

Vegetarian Pedestrians.—The result of a pedestrian contest recently completed between Berlin and Vienna was a triumph for two vegetarian walkers, who came out a long way ahead of their carnivorous competitors. The fact corresponds with other evidence of the enduring power of non-meat-eaters. If there is one thing certain, says an English journal, remarking on the achievement, about the races that eat no meat, it is that they can march. "Thousands, probably scores of thousands of Sikhs and Hindostanees would have performed the German feat, and not have thought at the end of it that they had done anything wonderful; and they not only eat no meat, but they are the descendants of men who have eaten no meat for perhaps two thousand years. They have eaten wheat

or millet, and drunk plenty of milk; and they can walk rapidly as long as life remains in them. A Sepoy regiment which means it will walk a European regiment to death, and do it on food which their competitors would pronounce wholly insufficient to sustain vigorous life. A regular Hindostanee carrier, with a weight of eighty pounds on his shoulders—carried, of course, in two divisions hung on his neck by a yoke—will, if properly paid, lope along over a hundred miles in twenty-four hours, a feat which would exhaust any but the best English runners." But the writer doubts whether this power of endurance is parallel with what is called physical strength.

Hypnotism in Remedial Treatment.—An unnamed writer, whose views are pronounced by the Lancet "eminently wise and judicious," has been publishing a series of articles in the London Times on the New Mesmerism, in which he identifies the hypnotism of the French and other neurologists of the present time with the mesmerism of a former generation and the hypnotism of Braid. He affirms that denial of the existence of hypnotism is out of the question. To the inquiry whether it is sufficiently beneficial to justify its use, he replies that "a method which has been already tried and found wanting ought not to meet with the same open reception as a new remedy. What would be mere caution in the latter case very properly becomes suspicion in the former." Quoting from the old authors to show that hypnotism was practiced in former days for the same maladies and with the same alleged results as to-day, he concludes that if it had possessed a real efficacy it would never have been allowed to fall into disuse. He accepts Charcot's view that the hypnotic condition is essentially morbid and dependent on a disordered brain, and that its employment is only justifiable in a few exceptional cases here and there. The writer sums up his conclusions by saying: "Hypnotism in treatment has a real but very limited value, and it should only be used with great care. It is not likely to die out altogether, but neither is it likely to be generally adopted, or even to spread much beyond its present limits. Hypnotic experiments, unless they have the patient's benefit in view, are injurious and unjustifiable alike on the platform and in the laboratory. Finally, if I may offer any practical advice to the public, it is this: Regard hypnotism with extreme caution, and do not resort to it except on the advice of an unprejudiced medical man in whose opinion you have implicit confidence."

Tree-top Vegetation.—The plants that grow in the tops of willow trees near Cambridge, England, have been recorded during the last few years. They represent eighty species, and have been found altogether 3,951 times among about 4,500 trees. Of the eighty species, only eighteen furnish one per cent each of the whole number of records; the others occurring only in very small numbers. Classifying the plants according to means of distribution, nineteen species, of which 1,763 records, or 44·6 per cent, occur, have fleshy fruits; three species with burs were found in 651 instances, or 16·4 per cent; thirty-four species, with winged or feathered fruit, gave 996 records, or 25·1 per cent; seven plants with very light seeds, 421 records, or 19·6 per cent; and plants whose means of distribution is poor or somewhat doubtful, 120 records, or 2·9 per cent. It is thus very strikingly shown how the various mechanisms for distribution succeed, for only the better ones present any considerable numbers in the list. The bird-distributed plants appear higher here than in such cases as the flora of the churches of Poitiers, because birds visit trees more frequently. The observations show that a seed is carried only a short distance by its mechanism for distribution. Plants are always found upon the soil within two hundred and fifty yards, at most, of those found in the trees. An analysis was made as far as possible of the birds' nests found in the trees, and pieces, often with ripe fruits, of many of the plants in the list were discovered in them; so that probably this means of distribution is of some importance.

Athletics and Scholarship.—Mr. William Odell, of Torquay, England, recently addressed the question to the headquarters of some of the large public schools as to whether the boys who excel in athletics are as a rule also excellent in school work, examinations, etc. A similar inquiry made by a Mr. Cathcart ten years ago elicited an-

swers that were full of enthusiasm and unstinted praise of athletics. The replies to Mr. Odell's questions are more reserved and critical. One correspondent answered that as a general and rarely broken rule, excellence in athletics and in intellectual work are not met with at the same time in the same person: another, that "the spirit of athleticism needs controlling." Dr. Hornby, of Eton, notes that "some years ago it was quite possible for a boy who had an aptitude for cricket or rowing to attain to the highest excellence, according to the standard of that day, in athletics and school work. I doubt whether it is so now. Athletics of all kinds have become so developed and brought into a system, and, I may almost say, professional, that the time required for a very high excellence in them is, I think, a serious obstacle to a reading man or a studious boy's engaging in them with a view to athletic distinction. This is a serious evil in our day"; and Dr. Percival, of Rugby, that "the great publicity given to athletics tends to give them an undue prominence in the minds of both boys and men." These replies suggest that physical education in public schools may have been overdone and overestimated, and that the enthusiasm of a few years ago may have carried matters further than was intended.

The Glory of Columbus.—In his presidential address before the American Geographic Society on Discoverers of America, the Hon. Gardiner S. Hubbard claims for Columbus, in the face of the recent attempts to depreciate his work, all the credit that has at any time been given him. There was no map published until after the sixteenth century, Mr. Hubbard says, that gave a correct delineation of the seacoast of America. "It is no wonder that Columbus never comprehended the nature or extent of his discoveries. The more we study the history and geography of the times, the influence of the Church, the difficulty of determining longitude, the ignorance of the movements of the mariner's compass and of the distance to Cipango, the greater will be our admiration for Columbus. Yet a recent writer speaks of the discovery of Columbus as a blunder, and others say, as if in disparagement of his work, that he knew of the discoveries of the Northmen, and was only following their track; that the chart of Toscanelli, which Columbus took on his first voyage, indicated clearly his route; that Columbus died in the belief that he had discovered Cipango and Cathay, never realizing that it was the New World, and that Americus Vespucius is entitled to the greater credit." Sebastian Cabot is quoted by the author in testimony of the admiration with which Columbus's discovery was received at the court of Henry VII, where it was affirmed "to be a thing more divine than humane to saile by the west into the easte, where the spices growe, by a chart that was never before knowen." It is very doubtful if Columbus knew of the voyages of the Northmen, nor would such knowledge have been of much value, for Greenland was then believed to be a part of Europe and joined to Norway. If Columbus had known of their discoveries and sought the countries they had found, he would have sailed northwestward instead of westward. Many before Toscanelli and Columbus believed the world to be round, and that by sailing westward Asia might be reached. Columbus not only believed but proved it. He made no blunder, for he sought land the other side of the Atlantic, and he found it. Vespucius knew little more than Columbus of the New World, and never realized that North America and South America were one continent. The maps show that learned geographers long after the discoveries of Columbus, Vespucius, Cabot, and Magellan, did not understand the geography of the New World. "All voyages before that of Columbus had been coasting voyages, the sailors keeping in sight of land. Columbus pushed into the unknown and trackless ocean, leaving the land far behind. Good seamen were unwilling to undertake such a voyage, so convicts were obtained, liberated from prison on condition of sailing with Columbus. A brave, resolute, and self-contained spirit was necessary to command such a crew on such an expedition. New wonders startled him each day. . . . No voyage like that was ever made before, and none like it can ever be made again, for the great discoverer solved the problem and reached the east by sailing west."

The Pose of Egyptian Drawings.—The first thing that a Western observer remarks

in the pose of Egyptian drawings of the human figure is that it is an impossible combination according to our ideas. We see the face in profile, the eye full length, the chest in front view, and the legs sidewise. But before we condemn this as contrary to Nature, it is well, as Prof. W. M. Flinders Petrie suggests, to see what the attitude of a modern Egyptian is, and how far our notions are correct. To avoid all ideas of posing for the subject, he selects the figure of a boy from a large group that was photographed without any special aim by a Cairo dealer. In the kneeling figure are seen the profile of the face, the eye full, the chest in front view, and the legs sidewise. Everything that we have heard condemned as unnatural and impossible in the ancient sculpture is seen in the modern native, without any constraint, when simply taking an easy position. This shows what is the true ideal of the conventional Egyptian pose; it is a three-quarters view, modified by the omission of the much foreshortened parts beyond the profile—a simplification which was essential to an outline system of representation.

Variety in the Eyes of Animals.—It is hard, in studying some of the lower animals, to determine whether they have a proper sense of vision. They can all recognize light and distinguish it from darkness; but that is probably all the sight that a few organisms possess. In such creatures as earthworms, for instance, the whole skin is supposed to be sensitive to light; and there is some evidence that they have a choice between colors. Mollusks have eyes of various qualities: those of the snail distinguishing light from darkness; those of the cuttlefish very highly developed; the unique and curious eyes of the nautilus; and the two kinds of eyes of the onchidium. Some of these animals possess the power of restoring their eyes, as well as other lost members, when they are cut off. Great differences appear in the organs of sight of crustaceans. They are of all sorts, from a simple eye-spot in some species up to two compound eyes on a movable eye-stalk (as in the crab and lobster), with complete optical apparatus; and some have both simple and compound eyes. Most insects have two kinds of eyes: the large compound eye, one on each side of the head; and the ocelli, or simple eyes, of which there are generally three, placed in a triangle between the other two. The compound eyes are complex in structure, consisting of a number of hexagonal facets, each with its system of nerves. It is not known whether the combination forms one aggregate eye, or whether each facet is an eye. Many insects have thousands of these facets—some beetles as many as twenty-five thousand. The vision of scorpions, though they have six eyes, is imperfect; and that of spiders, equally well provided as to the number of ocelli, is not much better. The dexterity and unerring aim with which many reptiles catch their insect food in the air proves that they have very keen vision. The chameleon has the additional faculty of moving its eyes independently of each other, so that it can look up with one eye while looking down with the other, backward and forward, or in other different directions. The eyes of deep-sea fish are very varied: some have no eyes or sight; some have greatly enlarged eyeballs; and others are provided with phosphorescent processes or spots. Birds and many of the smaller mammals have very acute vision, while that of the larger animals is very much like our own.

Co-operation in Nature.—That crude competition is the universal law of Nature, while combination is the invention of the mind of man, is doubted by Mr. Henry Farquhar. The position, he says, is "difficult to reconcile with even the most hasty consideration of ruminants feeding in herds, where, instead of a tumultuous crowding for the occupation of the best places, we see some individuals taking posts in which they can be of service in warning the whole herd of impending danger—or of the wolves that prey upon them in co-operating packs. It is not to be rashly claimed that mind . . . is absent from the conduct of the ant and her colonies; but surely their example is convincing evidence that the lesson of the economic superiority of concert over cutthroat individual competition is one that has been well taught and learned in realms of Nature widely sundered from ours. . . . If not with man as a self-conscious being, where in the course of evolution does an implicit recognition of the wastefulness of indiscriminate competition

begin? Not even, I think, with the first appearance of gregarious animals. It is found at the point where parents first begin to care for their feeble offspring. . . . We may go back further yet—much further. It is an application of the same principle essentially unchanged when the organic cells, which are in the lower organisms independent beings, first unite in filaments to form an aggregate of the second order, each cell giving up a part of the strength with which it could carry on a rivalry with its comrades, for a power of co-operation which makes the aggregate far better able to sustain itself than as many separate rival cells could ever be."

The Biloxi Indians.—The title Biloxi, as applied to the Biloxi Indians of Louisiana, said Mr. J. Owen Dorsey, in a paper read at the American Association, was probably a corruption of the name they gave themselves, Lakes or Lakeau, meaning the first people. They lived in 1669 at Biloxi Bay, Mississippi. In 1763 they moved to Louisiana, where their number has been reduced to seventeen. Descent among them is in the female line. A Biloxi can not marry his wife's brother's daughter or his father's wife's sister, wherein they differ from the Sioux, but a Biloxi man can marry his deceased wife's sister, and a Biloxi woman can marry the brother of a deceased husband. They believed that the spirit of a deer revived and went into another body, and this could be repeated thrice; but when the fourth deer was killed the spirit never revived again. The thunder being is very mysterious and must not be talked about in cloudy weather, but only on a fair day, when thunder stories may be told. When the Biloxi see a humming bird they say that a stranger is coming; and the humming bird, they believe, always tells the truth. The crackling of the fire is supposed to be a sign of snow or rain, and a nuthatch pecking the house a sign of coming death. If a child steps over a grindstone its growth will be stopped. Snipe must not be killed or eaten, because the bird always gathers deer fat, and is the sister of the thunder being.

Playing with Electric Eels.—A writer in the London Spectator has described his experiences in handling the electric eels in Regent's Park, the largest of which is about four feet and a half long, and weighs between sixteen and eighteen pounds. "When grasped in the middle of the back, there was just time to realize that it had none of the 'lubricity' of the common eel when the first shock passed up the arm with a 'flicker,' identical with that which a zigzag flash of lightning leaves upon the eye, and, as it seemed, with equal speed. A second and third felt like a blow on the 'funny-bone,' and the hand and arm were involuntarily thrown back with a jerk which flung the water backward on the pavement and over the keeper, who was kindly assisting in the enterprise. This slight mishap recalled a far less agreeable result of a shock inflicted on a previous inquirer, whose recoiling hand had struck the assistant a severe blow in the face. Unwilling to be baffled by a fish less in size than the salmon which form the common stock of a fishmonger's window, the writer once more endeavored to hold the eel at any cost of personal suffering. But the electric powers were too subtle and pervading to be denied. The first muscular quiver of the fish was resisted; but at the second the sense of vibration set up became intolerable, and the enforced release was as rapid and uncontrollable as the first. The smaller eel was neither so vigorous nor so resentful as its fellow; but though the first and second shocks did not compel the grasp to relax, a third was equally intolerable with that given by the large fish. The electrical power seems to increase rapidly in the heavier eels." The writer thinks that the eel controls at will the power of its electrical discharge.

The Earliest Man.—In his public lecture at Madison, Wis., during the meeting of the American Association, on The Earliest Man, Prof. D. G. Brinton said that science inclined to the belief that man originated in one spot, and that all others descended from one first pair. Some eminent men of science believed that man was on the earth even in the Tertiary period. What is called the present period was divided many thousand years ago by the Glacial period; and it was probable that in certain parts of the world man lived during the ice period, which would place the antiquity of the race at least 100,000 years. Man could not have first appeared

on any small island nor in such cold regions as would expose him to death from that cause, nor anywhere where the remains of the highest animals below him were absent. This reasoning excluded Australia, all of America, South Africa, South India, northern Europe, and northern Asia. Nor did it permit the acceptance of the ancient Atlantis as that sunken land which Haeckel named Lemurea. It left only, in fact, the southern slope of that great mountain chain which began on the east with the Himalayas and extended to the farthest west of Spain. There also were found man's very oldest remains and weapons, and the oldest of them all in western Europe, in France and Spain. On the present evidence it must be said that man originated in western Europe or northern Africa. The earliest man was of the average height of men of to-day, muscular and strong, walking not always erect, but stooping forward. His skin was hairy, of a reddish color, and the women were somewhat smaller than the men. His forehead was low, but his brain was fairly well developed. He knew the use of fire, how to make weapons of stone, bone, and wood, traps for animals, and some kinds of boats. Then he used some sort of shelter; he lived in communities; he had a language; he loved his family and took care of the sick, but he did not seem to have had a religion. He was brave in battle and loved to roam. All this can be proved by a careful study of his remains. It was concluded, therefore, that the earliest men were of the same spirit and soul with ourselves, endowed with like faculties and with a similar capacity to advance.

Inheritance Taxes.—Mr. Max West, in his study of that subject (Columbia College Series in History, Economics, and Public Law), finds the recognized origin of the inheritance tax in its imposition by Augustus in Rome, 6 A. D.; but thinks it probable that the Romans borrowed the idea from the Egyptians. There are evidences that Egypt had an inheritance tax, probably of not less than a tenth, from which even direct heirs were not exempt. A papyrus has been found which relates that a certain Hermias was sentenced in a heavy penalty for failing to pay the tax on succeeding to his father's house. Another inscription records a sale of property by an old man to his sons at a nominal price, apparently for the purpose of evading the inheritance tax. Mr. West's review of the history of the tax in different countries and through its various phases leads him to the conclusion that it is pre-eminently an institution of democracy. It is found in nearly every civilized country, but it is only in the most democratic countries—Great Britain, France, Switzerland, Canada, and the Australasian colonies—that it reaches its fullest development, with high and usually progressive rates, and becomes an important source of revenue. The United States seems thus far to be an exception to this rule, but the increasing popularity of this mode of taxation, and its rapid extension from State to State, indicate that at no distant day it may be general in America. In the assessment of the tax a graduation according to relationship is nearly universal in practice. Direct heirs are in many cases exempted, and in others are taxed very lightly, as compared with collateral and distant heirs. A progression in the rate of the tax corresponding with increase in the amount of the estate is sometimes adopted. Bequests for public, benevolent, and educational purposes might well be exempted, for in such cases, if the gift is wise, the whole amount accrues for the benefit of the community. The question of what to regard as inheritances for purposes of taxation is sometimes a difficult one. A bequest of freedom to a slave has been held to be taxable. A succession is sometimes defined as any beneficial interest in property accruing in possession or expectancy on the death of any person. The English law includes interests accruing by survivorship in the case of joint ownership, by general powers of appointment, and by the extinction of determinable charges; but life insurance is excluded. That the inheritance tax is regarded as something more than a purely fiscal measure is shown by frequent proposals to use the proceeds for benevolent or educational purposes. Such proposals have sometimes borne fruit in legislation.

Fish Culture in America and Europe.—It appears from a statistical review of fish culture in Europe and North America, prepared by N. Borodine, of the Russian Association of Pisciculture and Fisheries, that the eighty

fish-hatcheries in North America (sixty-six in the United States and fourteen in Canada and Newfoundland) produced in the year of their last report 1,616,027,192 fish hatched; and four hundred and sixteen hatcheries in Europe, 277,973,016 young fish. The North American hatcheries are all governmental; most of those in Europe are in private hands. The average production of one hatchery is 668,000 in Europe and 13,400,000 in North America. In Europe the largest amount of money for fish-cultural works is spent in Germany—the most by the Deutsche Fischerei Verein. France, which has contributed more than any other nation toward the development of piscicultural work, now ranks behind several other countries. Italy has recently begun piscicultural work under the control of the Government. The appropriations for this work by the Government of the Netherlands are small, while none are made by Austria-Hungary. The appropriations of the British, Russian, and Swedish Governments are also small. "When," says Mr. Borodine, "we compare the total amount of $37,032 spent for piscicultural work by all European countries with the appropriations of North American countries, we shall not be surprised at the enormous difference in the amount accomplished in the Old and New Worlds. Europe originated and developed the methods of fish culture, but it has become an industry only in America."

NOTES.

The Primitive Woman as a Poet was the subject of a paper at the American Association by Prof. A. F. Chamberlain. Lullabies, the author said, are known in every land, and the folk poetry of all people is rich in songs whose text and whose melodies the tender mother has herself imagined and composed. But not alone cradle-songs are the product of the genius of the woman. As in modern so in primitive times maidens inspired by love have vented their feelings in song. We find such poetesses among the Arabs and Bedouins of the desert, in Polynesia and Australia, Madagascar, etc. Women improvisators are known among the American Indians, among the African tribes, etc. The share of woman in the transmission of song and story from generation to generation is very great. Indeed, among some of the tribes of Guiana the bards of ancient times are represented as old women. Among the Bedouins as elsewhere, women and girls have special songs which are never imparted to the men, and it is very difficult, often impossible, for a traveler to obtain the text of such songs.

In a paper on Indian Migration, read at the American Association, C. S. Wake endeavored to trace the migrations of the tribes from their traditions. An examination of these traditions, the author said, showed that besides the Algonkins, Iroquois, and the Cherokees, the people of the Sioux-Dakota stock also dwelt at an early date near the St. Lawrence. Probably all the people thus brought together in the neighborhood of the Eastern lakes had a common origin, the place of which may have been north of the St. Lawrence. The primitive long-headed Indians of North America spread originally over the continent from some part of the northwest coast, or the foreign element to which they owe their special characteristics was introduced there. This element has its nearest representative on the American continent in the Eskimo. The Eskimo skull approximates the type found among the Caroline islanders, the Fijians, and the aborigines of Australia. The long-headed tribes of North America may thus find their oldest allies among the islanders of the Pacific.

M. Marey has found, from his continued studies of animal locomotion by means of instantaneous photography, that the modes of progression of the viper and the eel are much alike; that the postures of batrachians in water (after they have acquired their limbs) are much like those of men swimming, and that lizards trot like horses.

A pair of catbirds having built a nest in a honeysuckle vine on the house of Dr. R. W. Shufeldt, he took the pains to observe their nesting habits. The first egg was laid twenty-four hours after the nest was built, and three others on three succeeding days, all very nearly at the same hour in the morning (between 9.15 and 10.35). For the first few days the mother bird sat on the eggs at irregular intervals, leaving them often for an hour or more, but finally gave them her undivided attention. On the fourteenth day from the first laying there were no birds hatched at dark, but on the next morning there were three; and the fourth egg was hatched during the next night. On the twenty-fifth day all the birds left the nest together; but not going away, the young were easily caught. They were put in a cage and hung under the roof close to the nest. Here the parents faithfully fed them through the cage wires for three days, when they were let loose in some dense underbrush, to the great joy of the parents.

The report of the managers of the Observatory of Yale University says that while only a small percentage of the thermometers sold are sent there for certification, it is presum-

ably true that those which are sent by the manufacturers are carefully selected and therefore far more reliable than the average of those sold without certification. Nevertheless, the testers are obliged to reject twenty-five, fifty, and even seventy-five per cent of those sent them. As a rule, these are not rejected without receiving double the time and care required by the large majority of those to which certificates are granted.

The course of instruction in naval architecture recently established at the Massachusetts Institute of Technology provides for a thorough training in the theory and methods of devising and building ships, together with a study of the properties requisite for safety and good behavior at sea. It is arranged to occupy four years, and leads to the degree of Bachelor of Science. It is intended to cover the same ground and accomplish the same results as the English and French Government schools for training naval constructors, and to give, in addition to professional and technical training and equipment, a good scientific and liberal education.

Hitherto disorders observed among workmen in hemp have been regarded as originating wholly in mechanical causes, as in the inhalation of vegetable dusts. Dr. L. Salomon, of Savigné l'Evêque, France, who has studied two cases of such disorders, attributes them to intoxication by the active principles of hemp, similar to those produced by hashish.

The Laboratory of the Psychological Institute at the University of Göttingen—described by Prof. W. O. Krohn as in many respects the best for research work in Germany—owes its excellent equipment to a liberal gift from a private person, the state contributing only a pittance to its support. This person is a former student of Prof. Müller.

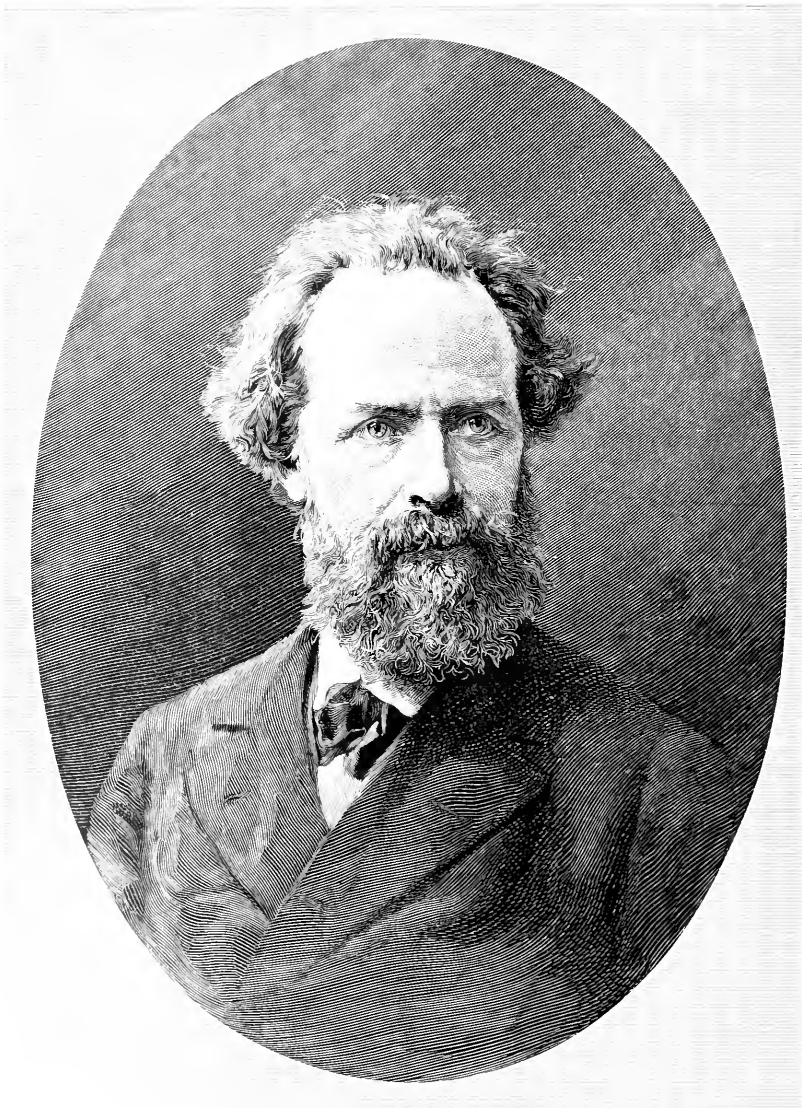
The Report of the Division of Entomology (Bulletin No. 29) on the Boll Worm of Cotton (*Heliothis armiger*) covers in the first part observations made by Mr. F. W. Mally upon the parasites and natural enemies of the insect, and presents in the second part bacteriological experiments made by the same observer with certain insect diseases affecting it. The paper also contains observations of the depredations of the larva upon corn, and upon the use of corn as a trap for it.

The courses of instruction in the Department of Geology of Colgate University, while designed to give such knowledge of the several subjects as a scheme of general education requires, are so arranged as to provide two years of continuous work to those who may wish to teach geology or pursue it as a profession. The instruction is given by lectures, with text-books for supplementary reading, oral and written reviews, and laboratory and field work. Besides the general collections of minerals, and in geology a dynamical collection, illustrating weathering, glacial action, the work of springs, underground waters and the ocean, the results of volcanic and mountain-building forces, the work of organisms, and various structures, with specimens illustrating lithology, and a systematic collection of fossil remains have been begun. In economic geology sample blocks of building stone have been acquired.

OBITUARY NOTES.

The death is announced of M. Daniel Colladon, of Geneva, one of the most eminent of the former generation of physicists, in the ninety-second year of his age. He was born at Geneva in 1802; became an engineer; studied physics and mathematics in Paris; returning to Geneva, performed in co-operation with Sturm, in 1827, his famous experiments on the propagation of sound in water. The two also studied together the resistance of materials and the compressibility of liquids. In 1829 he became Professor of Mechanics in the *École Centrale des Arts et Manufactures* in Paris; later, professor in the academy at Geneva. Near the beginning of his career he studied the properties of liquid veins, and executed the remarkable experiment of the transportation of luminous waves by a column of water, which is the basis of the curious luminous fountains. One of his most important discoveries was that of the use of compressed air as a medium for the transmission of energy—a discovery which has found practical application of great value in apparatus for perforating tunnels. He was also an earnest student of meteorological phenomena, and made many observations on lightning and hail. Like most students of broad minds, he took much interest in the popularization of science.

Henry J. Philpott, a writer who had gained considerable distinction in the discussion of economical subjects, died of consumption in Niles, Cal., September 24th. He was a resident of Iowa; had been engaged in editorial work in that State; and had gone to California as a last resort for the possible benefit of his health. He was prominent in the organization of the Free-Trade movement in Iowa; was interested in the work of the Society for Political Education of this city; and published many bright and forcible papers on the subjects he held near at heart. He contributed to The Popular Science Monthly articles or letters on The Joint-Snake Idiocy (vol. xxx); Social Sustenance (vol. xxxi); Origin of the Rights of Property (vol. xxxv); Irrigation of Arid Lands, and A Novel Water-Cooler (vol. xxxvi); A Little Boy's Game with a Ball (vol. xxxvii); and Almond Culture in California (vol. xli).



ÉLISÉE RECLUS.

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THE ETHICS OF TRIBAL SOCIETY.

BY PROF. E. P. EVANS.

THE world of the primitive man was bounded by the circle of his vision. He regarded the horizon as a fixed line which separated the earth from the sky, and which it would be possible for him to reach by going far enough. He did not deem it less real because it unfortunately always eluded his search, like the fabulous pot of gold which, according to popular superstition, lies buried at the point where the rainbow rests on the ground. In like manner the barbarian of to-day has no conception of the fact that the line of junction of earth and sky has no real existence, but is "all in his eye."

Indeed, it is but recently that man has learned to appreciate aright the wholly subjective character and significance of the terms north, south, east, and west as applied to places on the globe, and to recognize the relativity of all his geographical ideas, inasmuch as these are dependent for their accuracy and exactness upon the position of the speaker. It is one of the rare achievements of high culture, and has always been the prerogative of exceptionally thoughtful minds, to be able to distinguish between the apparent and the actual, to keep mental conceptions free from the influences of optical illusions, and not to be deceived by the surprises and sophistries of the senses.

An old English legend entitled The Lyfe of Adam, which has been preserved in a manuscript of the fourteenth century, relates how "Adam was made of oure lord god in the place that Jhesus was borne in, that is to seye in the cite of Bethleem, which is the myddel of the erthe." It then goes on to state that the first man was made out of dust taken from the four corners of the earth,

which meet in Bethlehem, and that he was called by a name composed of the four principal planets: thus he was formed as a microcosm, the miniature counterpart and organic epitome of the universe, the synopsis and symbol of all created things.

There is a tendency in every savage tribe and isolated people to regard the portion of the earth which it happens to inhabit, and especially the spot which is the cradle of the race or around which its sacred traditions cluster, as not only the political and religious but also as the physical center of the world. Such were Jerusalem to the Jews and imperial and papal Rome, *urbs et orbis*, to the ancient Romans and mediæval Romanists; such has Benares been from time immemorial to multitudes of Hindus, and such is Mecca to-day to millions of Moslems. Before the discoveries of the Western hemisphere, made by Columbus and his compeers, not even the most enlightened peoples had any proper sense of their relations to the rest of mankind, either morally or geographically. International ethics and comities began with the growth of clearer and more correct ethnical notions, and have always kept pace with it. The knowledge of the rotundity of the earth gave a strong and permanent impulse in this direction, and has contributed not a little to the recognition of the equal rights of all races of mankind.

The language of every civilized nation contains curious survivals of the primitive conceptions which sprung out of what might be called the self-conceited and self-centered spirit of the savage. It is interesting to note how a single people, emerging from barbarism and taking the lead in civilization at an early period, imposes its forms of speech, and especially its geographical terms, upon after ages and upon remote races of men for whom they have really no meaning. We still speak of certain countries as the Levant and the Orient, the Ἀνατολή of the Greeks, but these designations have no significance except for the dwellers on the shores of the Mediterranean, with whom they originated. So, too, Asia means etymologically the land of the rising sun and Europe the land of the setting sun, and these names expressed the actual position of the two continents in their relation to the Greeks. But to an American, and especially to a Californian, Europe is an Eastern and Asia a Western continent, and these strictly ethnocentric appellations would be wholly unsuitable and extremely confusing were it not for the fact that their etymology has become obscured and their primitive signification been forgotten, or is at least lost sight of and ignored, so that they are now mere arbitrary terms or distinguishing signs, with no suggestion of the geographical direction or situation of the regions to which they are applied, just as we speak of Chester, Edinburgh, Oxford, Berlin, or Munich without thinking of a Roman camp, King Edwin's castle, a ford

for oxen, a frontier fortress, or a community of monks; and christen a child George, Albert, or Alexander without intending him to be a tiller of the soil, or wishing to imply that he is of noble birth, or will distinguish himself as a defender of men. All such proper names denote particular places or persons, but have wholly ceased to *connote*, as the scholastic philosophers were wont to say, the qualities or attributes which were at first associated with them and brought them into use.

The Chinese call their country the middle realm (*Chung-kuë*) or the flower of the middle (*Chang-hua*), thus characterizing it as the central and choicest portion of the earth, in distinction from the savage wastes inhabited by savage men outside of the Great Wall (*Wan-li-ch'ang-ch'ing*). The Jews looked upon themselves as the chosen people, set apart as *Yisrâêl*, or champions of the true God, and lumped all other tribes of men together as *goïm*, gentiles, poor pagan folks, who had no rights which a child of Abraham was bound to respect. The Greeks divided all mankind into two classes, Hellenes and barbarians; the latter were also called ἄγλωττοι—i. e., tongueless—because they did not speak Greek. Aristophanes applied the term βαρβαροι even to birds, on account of the inarticulateness and unintelligibleness of their chirpings and chatterings. It is from Greek usage that we have come to designate any corruption of our own language by the introduction of foreign or unfit words as a barbarism. The persistence of this primitive tribal conceit is shown by the fact that a people in many respects so cosmopolitan as the English can pronounce no severer censure and condemnation of the manners, customs, and opinions of other nations than to call them un-English, and really fancy that an indelible stigma attaches itself to this epithet. Not long since several British tourists in Italy actually protested against some foolish, perhaps, but otherwise harmless features of the Roman carnival, and demanded their suppression on the ground that they were "thoroughly un-English," thus virtually assuming that no amusements should be tolerated on the Tiber which were not customary on the Thames. It is due to the same feeling that the word "outlandish" has gradually grown obsolete in its original sense, and is now used exclusively as an expression of contempt. Slavonic (*slovene*) is derived from *slovo* (speech), and means people with articulate language; whereas the Slavic nations call the Germans *Němĭcĭ*, which signifies speechless, dumb, and therefore barbarian.

Geocentric astronomy and ethnocentric geography have been relegated long ago to that "limbo large and broad" which is the predestined receptacle of all exploded errors and illusions engendered by human vanity and ignorance; but from the bondage of ethnocentric ethics, manifesting itself in national prejudices and

prepossessions, and often posing as a paragon of virtue in the guise of patriotism, even the most advanced and enlightened peoples have not yet fully emancipated themselves. The Hebrews thought they were doing the will of their tribal god (the personification of the tribal conscience) by borrowing jewels and fine raiment from their too-obliging Egyptian acquaintances and then running away with them. That this mean abuse of neighborly confidence and civility was not a mere momentary freak of fraudulence or sudden succumbing to temptation, but the outcome of settled principles of morality and a general rule of policy, is evident from the approval with which it is recorded, as well as from the laws subsequently enacted, which permitted them to take usury of aliens and to sell murrain meat to the strangers in their gates.

This is the kind of ethics which finds expression in the legislation of all barbaric and semi-civilized races, from the Eskimos to the Hottentots. The Balantis of Africa punish with death a theft committed to the detriment of a tribesman, but encourage and reward thievery from other tribes. According to Cæsar's statement (De Bello Gallico, lib. vi, c. 23), the Germans did not deem it infamous to steal outside of the precincts of their own village, but rather advocated it as a means of keeping the young men of the community in training and rendering them vigilant and adroit. But we need not go to African kraals or American wigwams or primeval Teutonic forests for illustrations of this rule of conduct. Quite recently a Frenchman succeeded as *commis-voyageur* in swindling a number of German tradesmen out of large sums of money, and was applauded for his exploit by Parisian shopkeepers, who readily condoned his similar but slighter offenses against themselves on account of the satisfaction they derived from the more serious injury done to their hereditary foes on the Rhine. This incident proves how easy it is for the primitive feeling of clanship, euphemistically styled patriotic sentiment, to put in abeyance all the acquisitions of culture and set the most elementary principles of honesty and morality at defiance. International conscience is a product of modern civilization, but it is still a plant of very feeble growth—a sickly shrub, whose fruits are easily blasted, and for the most part drop and decay before they ripen.

Sir Henry Sumner Maine, in his Lectures on the Early History of Institutions, has shown with admirable force and suggestiveness that rude and savage tribes uniformly regard consanguinity as the only basis of friendship and moral obligation and the sole cement of society. The original human horde was held together by the same tie of blood-relationship that produces and preserves the consciousness of unity in the animal herd or causes ants and

bees to lead an orderly and mutually helpful life in swarms. In all these communities the outsider is looked upon as an outlaw; whoever is not a kinsman is a foe, and may be assailed, despoiled, enslaved, or slain with impunity. Indeed, it is considered not only a right but also an imperative duty to injure the alien by putting him to death or reducing him to servitude. The instinct of self-preservation asserts itself in this form with gregarious mammals and insects; and all primitive associations of men are founded upon this principle and cohere by force of this attraction.

A superstitious regard for blood pervades all early ideas and institutions of mankind. The ancient Hebrews were forbidden to eat the blood of a slaughtered animal, because the blood is the life; and the orthodox Israelite still clings to this notion and will not partake of butcher's meat that is not *gosh* or ceremonially clean—i. e., from which the blood has not been carefully drained off, although he knows that this process of ritual purification deprives the flesh of much of its succulence and nutritive value as food.

It is a widely diffused belief among aboriginal and lower races that the blood is the seat of the soul; hence blood-relationship is synonymous with soul-relationship. The child was also recognized as a blood-relation of the mother, but not of the father. Out of this conception of consanguinity arose the custom of descent in the female line, whereby the children of a man's sister became his heirs to the exclusion of his own offspring. Curiously enough this notion is confirmed, to some extent, by modern science, which would ascribe to the female the function of conserving and transmitting the permanent qualities and typical characteristics of the race, whereas the influence of the male in propagation is variable, innovating, and revolutionary, and tends to produce deviations from the hereditary norm.

Cannibalism, too, as a tribal rite, originated in the belief that the soul resides in the blood, and that by drinking the blood of the bravest foemen their courage, cunning, and other distinctive and desirable traits may be acquired and thus serve to increase the fighting force and efficiency of the tribe.

Brotherhood was also created artificially or ceremonially by mingling a few drops of the blood of two persons in a cup of wine and drinking it. Each received into his veins a portion of the other's blood, and thus they became blood-related and were bound by the same mutual obligations as they would have been if the same mother had given them birth. The heroes of old German sagas are represented as drinking brotherhood in this manner; it is thus that Gunther and Siegfried swear inviolable friendship and fidelity in Wagner's *Götterdämmerung;* and German students, in the festive enthusiasm of a *Commers,* are fond of imi-

tating their mythical forefathers in the solemn celebration of this mystic rite.

It is interesting to note the rhetorical and metaphorical survivals of this once strong conviction. In referring to political parties in France the Journal des Débats recently remarked: "It is not true that our nation consists of two nations—the heirs of the Emigration and those of the Revolution. This distinction no longer exists. The last vestiges of it have been obliterated on the battlefields, where all Frenchmen have mingled their blood. France is henceforth one and indivisible."

The noble sentiment expressed by the Greek comic poet Menander and handed down to us in the language of Terence, his Roman imitator, "I am a man, and regard nothing human as alien to me," was doubtless shared by many individual thinkers of antiquity, especially among the Greek Stoics and their Roman disciples. Cicero, who may be taken as one of the most eminent representatives of this ethical school, lays great stress upon "love of mankind" (*caritas generis humani*), in distinction from the love of kindred or countrymen. "A man," he says, "should seek to promote the welfare of every other man, whoever he may be, for the simple reason that he is a man"; and declares that this principle is the bond of universal society and the foundation of all law. He returns to this topic again and again, and never tires of enforcing this doctrine as fundamental in his treatises on duties (*De Officiis*), on the highest good and evil (*De Finibus Bonorum et Malorum*), and on laws (*De Legibus*). That he regarded this broad, cosmopolitan view as a new departure in ethics is evident from his remark that "he whom we now call a foreigner (*peregrinum*) was called an enemy (*hostis*) by our ancestors."

The distinguished Christian apologist Lucius Lactantius bases the duty of human kindness upon the hypothesis of human kinship, thus reviving and amplifying the old tribal notion which limits moral obligation to those who can claim a common progenitor. "For, if we all derive our origin from one man, whom God created, we are plainly of one blood; and therefore it must be deemed the greatest wickedness to hate a man, even though he be guilty." He adds that "we are to put aside enmities and to soothe and allay the anger of those who are inimical to us by reminding them of their relationship. . . . On account of this bond of brotherhood God teaches us never to do evil, but always to do good." He also quotes a passage from the Epicurean Lucretius to the effect that "we are all sprung from a heavenly seed and have all of us the same father"; and draws from this statement the conclusion that "they who injure men are to be accounted as savage beasts."

Lactantius has been surnamed the Christian Cicero, but the

fundamental principle of his ethics, as formulated in his Divine Institutions, is in its motive character and moral elevation far below the height attained four centuries earlier by his pagan prototype. The results of their teachings, practically applied, were equally cosmopolitan; inasmuch as Lactantius based his theory of duty on the Hebrew legend of the origin and descent of man, and thus enlarged his essentially tribal system of ethics so as to embrace the whole human race.

Marcus Aurelius defines his own ethical and humanitarian standpoint with his wonted epigrammatic terseness: "As an Antonine, my country is Rome; as a man, it is the world." Unfortunately, the liberal spirit of the philosopher, even when he happens to sit upon a throne, seldom exerts any direct and decisive influence in liberalizing the minds of the masses of mankind. Homer praises the kind and sympathetic heart of him who treats the stranger as a brother. But this fine sentiment does not change but rather confirms the fact that, as a rule, strangers were not thus treated in the Homeric age. As a general statement it remains true that in ancient times aliens had no legal rights whatsoever, and that international relations, so far as they existed at all, were relations of hostility.

But this outlawry *de jure* was mitigated *de facto* by investing the rite of hospitality with a certain sacredness. Such is still the case with all savage and semi-civilized tribes, as, for example, with the Bedouins, who hold the person of a guest inviolable, even though he may be their deadliest foe. This custom originated in the defenseless and helpless condition of the stranger, whose alienage placed him beyond the pale of law and the sphere of sympathy; it furnished a sort of compensation for the lack of all natural or conventional claims to protection, and thus supplied a temporary *modus vivendi*, without which intertribal intercourse would have been absolutely impossible.

We have an indication and illustration of this peculiarity of primitive society in the story of Cain, who, as a fratricide, was not only guilty of murder (a matter of comparatively small moment in the eyes of the aboriginal man), but also of treason against the tribe by violating the law of brotherhood fundamental to its constitution and essential to its existence; and when, by reason of this crime, he was driven out of the sheltering circle and sanctuary of his own kith and kin and became a fugitive and vagabond in the earth, his first feeling was the fear lest he should be slain by any stranger who might chance to meet him. The Lord is also represented as recognizing the possibility of such a catastrophe, and as setting a mark upon him in order to avert it.

The stipulation contained in the Hebrew code, as well as in the code of other Eastern nations, which made it the duty of a man to

wed his brother's widow, provided the first union was childless, and to raise up seed to the deceased, was only a modification of polyandry and differed from the conjugal relations still in vogue among the Thibetans in the fact that the possession of the same wife was successive instead of simultaneous. Both of these matrimonial customs are survivals of the earliest form of marriage, which was not individual, but tribal. We have a relic of this primitive kind of wedlock among the Californian Indians, who practiced promiscuous sexual intercourse, so far as the members of the same tribe were concerned; the woman was regarded as faithless or adulterous only when she cohabited with a man belonging to another tribe.

The Greeks, with all their superior culture, never became as a people sufficiently enlightened to lay aside their deep distrust and depreciation of foreigners. Sparta was notoriously hostile to strangers (ἐχθρόξενος, or guest-hating), and how impossible it was for even a cultivated Athenian to look at the world at large from any but a strictly Hellenic point of view is curiously and comically illustrated in the drama in which Æschylus glorifies the battle of Salamis, where the Persians are made to speak of themselves as barbarians balked of their purpose, and to describe their lamentations over their defeat as dismal barbaric wailings.

It is a somewhat surprising and quite significant concession to Greek arrogance that Plautus should use the phrase *vortere barbare* in the sense of turning or translating into Latin. It is possible, however, that he may have borrowed this phrase from Philemon and other Greek playwrights, whose comedies he imitated with more or less freedom, but always with a touch of native genius. Still, we know that the Romans were uniformly called barbarians, and seem to have recognized the correctness of this appellation down to the age of Augustus, when the term began to be applied chiefly, if not exclusively, to the Germans. As our earliest information concerning the Germanic peoples was derived from Greek and Roman sources, we have been misled by the use of this depreciatory designation to think of them as wild and lawless hordes, and to form a wholly false conception of the grade and quality of their civilization.

When individuals of different race or nationality formed friendships they were wont to confirm the pact by an exchange of tokens, which remained as heirlooms in their respective families, and were prized by their descendants as pledges of mutually kind and hospitable treatment. The duty of helpfulness was, in such cases, quite as imperative as is the vow of *vendetta*, which passes as a precious inheritance of hatred from Corsican father to son. These tokens were called by the Greeks σύμβολα, and by the Romans *tesseræ hospitales*, and, although they were eventually

superseded by better and more comprehensive methods and ended by playing only the frivolous part of a sentimental pastime in social life, like the modern philopena, they had originally a more serious purpose and were of no small importance as means of promoting intertribal intercourse and thus encouraging trade and leading to the establishment of commercial treaties.

Another step toward the realization of the conception of human brotherhood was the custom established at a very early period whereby chiefs of tribes came to address each other as kinsmen and members of one family. This assumption of consanguinity, which originated in the desire of dynasties to strengthen their position and to perpetuate their power, naturally led to increase of friendly intercourse and to frequent intermarriages, so that they finally became in fact what they at first claimed to be by a polite and politic fiction. Traces of this usage are found in the oldest records of royalty. Among the treasures of the Berlin and British Museums are preserved two hundred and forty-one tablets of cuneiform inscriptions containing letters written to Amenophis III and Amenophis IV of Egypt by Burnaburiash, King of Babylonia, and Dushratta, King of Mesopotamia, which show that, at least sixteen centuries before the Christian era, "dear brother" was the ceremonial title of salutation which monarchs were wont to use in their epistolary correspondence. This feigning of a common lineage still survives among crowned heads, and the vilest plebeian adventurer who, by force or fraud, gets himself proclaimed king or emperor is admitted to the select circle of sovereigns and greeted as "dear cousin."

Principles, once grown obsolete, are denounced as prejudices; religious beliefs, which have been supplanted by superior creeds, are scoffed at as superstitions; and dethroned deities haunt the imagination of their former worshiper as demons. In like manner, the lower classes of civilized communities correspond, in a measure, to the lower races, and reflect atavistically the ideas and passions of primitive man; and in periods of great social and political upheaval we are often rudely brought face to face with tumultuous masses of these strata of palæozoic humanity violently and unpleasantly thrown to the surface. It crops out in the English boor, who at the sight of a stranger is ever ready to "'eave 'arf a brick at 'im," and would deem the neglect of this duty a treasonable lack of local patriotism and loyalty to time-honored tradition; in the Cretan herdsman, who instinctively seizes his cudgel whenever a traveler in trousers passes by; and in the Egyptian fellah, who teaches his children to spit at every man with a hat on and cry out: "*Yá nasrâniy! Yá khinzîr!* O you Nazarene! O you pig!"

The publican, in some parts of southern Italy, is still disposed

to reckon with the foreigner as a foe, a forlorn vagabond, whom it is his native-born privilege to spoil. The blood of his ancestor, the brigand, courses in his veins, and his first impulse is to plunder the wayfarer. Prudence and the police may curb this progenital, predatorial proclivity; but the self-restraint always costs an effort, and, as a compromise with his instinctive feelings, instead of relieving the guest of his purse by force, he robs him of an undue portion of its contents by adding two or three hundred per cent to the usual price of fare and lodgment.

In many cantons of Switzerland, and especially in the Bernese highlands, we have the spectacle of a whole people apparently born and bred to consider mountain passes, romantic valleys, glaciers, and waterfalls as so many traps for curious and unwary tourists, and to prize sublime scenery merely as a ready-made snare to catch coots, dupes, gulls, boobies, and other varieties of too confiding summer birds of passage, which the categorizing mind of the German has reduced to two essentially distinct but closely connected classes, *Bergfexen* and *Sommerfrischler*.

This clannish spirit even invades and desecrates the courts of justice, and the Helvetian Themis is especially notorious for her propensity to blink the legal rights of the case and to tip the balance in favor of her cantonal or federal compatriots as opposed to the stranger within her gates.

In France the *droit d'aubaine* or *jus albinagii* confiscated to the crown the property of all aliens who died within the limits of the realm, to the exclusion of the natural heirs, unless these happened to be the king's subjects. This barbarous law was abolished by a decree of the National Assembly on the 6th of August, 1790, but was re-enacted twelve years later and incorporated in the *Code Napoléon*, modified, however, by a clause making the testamentary capacity of aliens dependent upon reciprocity; in other words, it was stipulated that the will of a foreigner should be declared valid in France, provided the laws of the said foreigner's country placed on the same footing the will of a Frenchman deceased within its jurisdiction. On the 14th of July, 1819, the *droit d'aubaine* was finally abrogated throughout the entire kingdom, after having been already considerably mitigated and partially annulled by the municipal authorities of Lyons and other industrial and commercial cities, which found this relic of mediæval legislation a serious obstruction to foreign trade.

Akin to this system of right was the German *Wildfangsrecht* or *jus wildfangiatus*, also known as *jus kolbekerlii*, which, as the term implies, accorded to human beings the privilege which game laws guarantee to the quarry, namely, that of being legally hunted. *Kolbenrecht* is equivalent to club law. An old and often quoted proverb, *Kolbengericht und Faustrecht ward nie schlecht*—the

law of the strong was never yet wrong—is the cynical expression of protesting submission to the inevitable, recognized as outrageous. It is the same bitter sarcasm that mocks at unjust and irresistible power in the popular saying, "Might makes right"; it is despair taking refuge and finding relief in ironical humor, which turns the first principles of ethics topsy-turvy.

Wildfangsrecht was originally applied to fugitive serfs and to strangers, but was soon extended to bastards and bachelors, gleemen and professional champions in ordeals by battle, all of whom lived more or less in a state of outlawry as to their persons and property, and could, under certain circumstances, be reduced to the condition of chattels. Foreigners who could prove the place of their nativity were subjected to a poll tax (*cherage*) for the protection vouchsafed to them by the reeve or *Vogt*, and were therefore called *Vogtleute*. In the Canton de Vaud and elsewhere in Switzerland this pollage is still levied as *permis d'établissement*, a lingering vestige of mediæval extortion which the most enlightened European governments have now abolished. Persons of unknown origin were treated as waifs (*épaves*), the mere flotson and waveson on the drifting tide of humanity, and were liable to be seized and envassaled by any petty lord on whose territory they chanced to strand. Perhaps a diligent study of these old laws might suggest to American legislators some drastic means of purging the country of tramps.

In "the good old time" in England any alien could be arrested and punished for the crimes and misdemeanors of other aliens, although having no complicity with them. They were all lumped together as a class, any individual of which was liable to be apprehended and held accountable for the debts incurred or for the offenses committed by any other individual of the class.

The idea of justice implied by such a proceeding corresponds to that entertained by the aboriginal Australian or American, who, when his wife dies, feels himself in duty bound to kill the wife of some member of another tribe, and avenges an injury inflicted upon him by a white man by slaying the first white man he happens to meet. The loss or offense, whatever it may be, is tribal, and is satisfied with tribal expiation or retaliation.

A case of this kind occurred quite recently in Dakota. A Sioux Indian, on the death of his squaw, went forth from his lodge with his gun and shot a missionary who was passing by. The red man had no grudge against the white man as an individual; on the contrary, he was personally fond of his victim, from whom he had received many acts of kindness; but the vow of vengeance was as sacred as that made by Jephthah the Gileadite, and had to be as religiously kept.

The old English custom, just referred to as a survival of the

earliest and crudest conception of tribal ethics, prevailed at least as late as the reign of Edward III—i. e., till about the middle of the fourteenth century; and long after this period it was exceedingly difficult to enact and almost impossible to enforce laws for the protection of foreigners, so deeply rooted and intense was the prejudice against them. Even far down into the eighteenth century they continued to be regarded with extreme suspicion, and were often subjected to gross indignities, independently of any personal qualities or any peculiar conduct on their part. The mere fact of their alienage sufficed to kindle against them the anger of the populace and turn the masses into an unruly mob. This is still the mental attitude of the cockney, and cockneyism is only a local form of philistinism by no means confined to the precincts of Bow Bells.

The laws of Venice, as expounded by Portia in the case of Shylock *vs.* Antonio, discriminated against aliens as opposed to citizens in a manner extremely fatal to the plaintiff and exceedingly characteristic of mediæval legislation.

Under the influence of the political panic caused by the excesses of the French Revolution, Lord Grenville succeeded, in 1793, in persuading the British Parliament to pass an alien bill, in which the spirit of feudalism reasserted itself; and since the abolition of this retrogressive law, which was effected chiefly through the enlightened energy of George Canning, the leaders of the Tory party have repeatedly endeavored to re-enact it. In every age and every country landed aristocracies have always shown a marked tendency to narrowness, provincialism, and distrust in their international relations. Indeed, from time immemorial, agricultural communities have been excessively conservative in this respect and hostile to progress; whereas commercial states and cities, whose prosperity is in proportion to their cosmopolitanism and dependent upon it, are naturally philallogeneal (to coin a word from the Greek of the Alexandrian patriarch Cyril, who unfortunately seldom exemplified in his conduct the virtue expressed by the epithet), or friendly to foreigners and easily accessible to influences from without.

Even in America, where all portions of the population are more mobile and undergo more rapid and radical changes than in other lands, the farmers are notoriously tenacious of old ideas and suspicious of reformatory movements of all kinds, following their traditions and clinging to their prejudices long after artisans and other handworkers of the manufacturing centers and large cities have cast aside these notions as obsolete and injurious.

All European governments appear to be periodically or epidemically affected with spasms of antipathy to aliens. France suffered from a particularly severe attack of this sort just before

the Napoleonic *coup d'état,* and now betrays serious symptoms of a relapse, which it is to be hoped do not portend an imperial restoration. As a rule, such manifestations may be regarded as evidences of internal derangement, which is pretty sure to break out sooner or later in some violent disorder. Knownothingism in the United States was the symptom of such a crisis, although its indications were at that time only partially understood.

It is but recently, in fact, that civilized nations have rid themselves of the most obnoxious relics of ethnocentric prejudice in their legislation—such, for example, as the *gabella hereditaria,* which discriminated against foreigners in matters of inheritance; and the *detractus personalis,* which virtually punished emigration by the imposition of a heavy fine. These vestiges of vassalage were removed from the statute-books of the German states in relation to each other by the acts of federation of 1815, and have been successively abolished between Germany and other countries by independent treaties.

The English law of extradition with other European powers still refuses to deliver up or to prosecute an Englishman who has committed a felony in a foreign land, unless the crime has been committed against one of his own countrymen. Some years ago a case of this kind occurred in Zurich, and still more recently in Munich. In the latter instance, one of the burglars, although residing in London, proved to be an American by birth, and was therefore handed over to the Bavarian police, and finally sentenced to ten years' imprisonment, while his English confederate in crime was set at liberty. Here we have, as the result of insularism, a survival of ethnocentric ethics in its crassest and most offensive form, such as one would expect to find only among a people still in the tribal stage of development.

In the volume already cited, Sir Henry Sumner Maine not only shows kinship to have been the original basis of society, but also indicates the process by which mankind may have gradually grown out of this primitive condition. The head of the family soon became through natural increase the head of a clan or tribe. The patriarch possessed the authority and exercised the functions of a chieftain over his lineal and collateral descendants, who were known as his men and were called by his name. He was honored and obeyed as their first man, *Fürst,* or prince, their stem-sire or king, an appellation which has nothing to do with personal "canning" or cunning, as Carlyle, in his excessive admiration of human force and faculty, would fain make us believe, but refers solely to race (*kuni*). The ruler was an ethnarch in the strictest sense of the term, and held his position by virtue of his primogenitureship or procreative seniority.

The correctness of this theory, so far as the genetic connection

of the tribe with the family is concerned, may be questioned. Instead of the former being an aggregation or expansion of the latter, it is highly probable that the primitive tribe is older than the family and the product of promiscuous sexual relations, and that families originated in a subsequent process of domestic differentiation. Polyandry and the custom of tracing descent exclusively in the female line would seem to point in this direction. The institution of the family, even in its polygamous form, presupposes a certain ethical element, which can hardly be predicated of primeval barbarism.

So, too, the most prominent feature in the social organization of the anthropoid apes and in all simian communities is the troop or tribe under the leadership of the most powerful male. A band of orang-outangs is doubtless an association of blood-relations, but there is no recognition of patriarchal authority as such and no evidence of distinct divisions into families. The community is a gregarious group of individuals joined in affinity, but not yet separated into single pairs with clearly recognized and jealously defended conjugal rights; and sovereignty is simply the assertion of superior force, although this constitution of the simian tribe does not entirely exclude the existence and exercise of moral qualities in the mutual relations of its members.

It is, however, a matter of no moment for the further evolution of society, whether, at the beginning, the family expanded into the tribe or was gradually differentiated out of it. The fact remains that the tribe was held together by the cement of consanguinity, and that the authority of the tribal head was derived primarily from the respect and reverence due to him as common progenitor, aided, of course, by his ability to enforce his claims to rulership in case an ambitious and rebellious Absalom should be disposed to question them. So strong and persistent is this sentiment that, even now, the number of a man's noble ancestors is supposed to entitle him, by the grace of God, to sovereignty, or to confer upon him some exceptional privilege and power.

With the transition from a nomadic to a sedentary social state, an important change takes place. No sooner has a people acquired fixed habitations and established permanent settlements than there arises the idea of ownership in the soil, and the chief of the tribe becomes the lord of the land. He is no longer merely the head of an organized body of roving men, but he also claims and exercises jurisdiction over a more or less definitely circumscribed district or domain and over all persons dwelling within its borders. Tribal sovereignty or chieftainship is thus superseded by territorial sovereignty or dominion, and with this transformation the state, in the modern sense of the term, really begins.

At this early stage, however, proprietorship in land was not

individual, but communal. It was the realization, to some extent, of the socialistic ideal of collective or governmental ownership of landed property, the return to which a modern school of reformers would fain persuade themselves and others to regard as a step in advance.

It is also interesting to note that this most important and epoch-making transition from pasturage to tillage was due to the initiative and activity of woman. Everywhere in the growth of society women have been the first agriculturists. While the men were leading the life of hunters or herdsmen, with frequent episodes of pillage and predatory warfare, women began to cultivate the soil and to rear domestic fowls, to spin and to weave, and to develop, in a rude way, various kinds of industry. This is the condition in which we still find all savage and semi-civilized tribes. Herodotus (vol. vi) says of the Thracians, "They regard tillage as the most degrading and pillage as the most honorable occupation." The savage looks upon all forms of manual labor, and especially husbandry, as ignoble, and therefore leaves such work to his squaw.

At first, her efforts in this direction were quite ignored and often thwarted by the sudden removal of the tribe to another place before she could reap the fruits of her toil. The little patch of ground which she had planted was deemed of small account, compared with the pleasures and products of the chase, and was frequently abandoned without hesitation before the meager harvest was ripe. For this reason barley was the earliest grain cultivated, because it is the hardiest of all grains and matures soonest. It was a long time before the fields tilled by women became of sufficient importance, as supplying means of subsistence, to keep the tribe settled for a whole season in one spot, or even to induce them to return thither in the autumn and remain there until the crop was gathered. This semi-nomadism was the first step toward a sedentary life and the starting point of a higher civilization, and woman was the chief agent in its accomplishment, although unconscious of the immense change which her humble efforts were effecting.

For a similar reason the weakest male members of the tribe were the first artificers and mechanical inventors. Men who were crippled or otherwise incapable of waging war and following the chase, if they had not been left to perish at their birth, remained at home and made hunting implements and weapons of war for their more vigorous and valorous tribesmen, and thus acquired skill in handicraft, sharpened their wits, and developed their inventive faculties. In mythology, the gods of the smithy, Hephæstus, Vulcan, and Veland, are represented as lame, and the experts in ores and workers in metals are dwarfs, gnomes, and creatures

of stunted growth. These physical peculiarities are not mere mythopœic whimseys and creations of the fancy, but correspond to real facts in the primitive history of the race, and point to the class of persons who were the earliest promoters of the arts.

The supersession of tribal by territorial sovereignty, although radical and permanent, was gradual and scarcely perceptible in its character, and did not begin to express itself in language till many centuries after the change had been fully accomplished. Mediæval and modern history furnish numerous illustrations of this process of social evolution and the manner of its operation. As Mr. Maine has remarked, there had been kings of England and of France long before John the Landless and Henry IV assumed respectively these official titles; although their predecessors had always been styled kings of the English and of the French. The Czar, who, while bearing sway as a territorial sovereign, preserves more than any other European ruler the peculiarities of a tribal chieftain, still calls himself Samodérshez, or Autocrat of all the Russias, and it was perfectly in keeping with the character and career of Napoleon I, as a *condottiere* on a colossal scale, that he took the title of "Emperor of the French." His interest was centered wholly in the army, which he loved and fostered in the same spirit that Tamerlane cherished his Mongolian hordes and Fra Diavolo his band of brigands. The King of Prussia bears the title of "German Emperor" (*Deutscher Kaiser*), not Emperor of Germany, since the latter would be inconsistent with the political existence and integrity of the other German states and a manifest usurpation of the rights and prerogatives (*Hoheitsrechte*) of the confederated princes and potentates. His imperial sovereignty is, therefore, essentially tribal; he is, so to speak, the chief of the German confederated monarchs, and exercises territorial sovereignty only as King of Prussia. There has been a long succession of Roman-German and German emperors, but never an Emperor of Germany.

A nomadic people, wandering from place to place, is not associated in any sense with the soil; the tribe remains the same, but not the territory it occupies. With the beginning of agriculture and sedentariness this relation is reversed. The conception of a nation, nowadays, implies fixed or at least well-defined geographical boundaries. Changes may take place in the character of the inhabitants and in the constitution of the government as the result of emigration and revolution; individuals and families may disappear and be superseded by others of a different stock, but the nation remains, as it were, *adscripta glebæ* within certain territorial limits and is not destroyed by any admixture of foreign with native elements in the population. Mr. Maine states this point very clearly and concisely when he says: "England was

once the country which Englishmen inhabited. Englishmen are now the people who inhabit England." An East Indian by blood may be an Englishman in the modern sense of the term as well as an Anglo-Saxon of purest lineage, however earnestly Lord Salisbury may deprecate the idea that a Hindu or any other "black man," even though he may be, like Dadabhoi Naoroji, a gentleman and a scholar, and the peer of the Tory premier himself in political wisdom and ability, should be sent to the British Parliament by an English constituency. It would seem, therefore, that, even at this late day, a man may be her British Majesty's first minister of state and yet entertain the notion, which prevailed in the days of Warren Hastings and still lingers among the subalterns of the colonial service, that an East Indian is a "nigger."

Nowhere is national feeling stronger and race feeling weaker than in the United States, where the negro, notwithstanding the prejudice growing out of his former condition of servitude, is as truly an American and as fully sensible of this fact as any scion of the Pilgrim fathers. It is unquestionable that the old Puritan stock is rapidly disappearing from New England, partly through natural extinction and partly through westward migration, and is being supplanted by Irish and Canadian French; but this circumstance does not blot New England from the map nor convert it into New Ireland or New France. On the contrary, the descendants of the Celtic immigrant are assimilated and transmuted by their environment and become New-Englanders. The consciousness of what might be called common territoriality tends not only to bind together and to blend diverse races into that "unity of a people" which constitutes a nation, but also to attenuate and to loosen the social and political unions, which are based upon common descent, and finally ruptures them altogether.

The aborigines of British America, who can not regard human beings otherwise than from a tribal point of view, still speak of the English as King George's men; but the inhabitants of Canada consider themselves Canadians irrespectively of their ancestral origin, and the same readiness to sink the claims of lineage when they conflict with territorial interests manifests itself even in the more recent colonies of Australia and New Zealand. Geographical contiguity proves, in such cases, stronger than genealogical connections; the old proverb, that blood is thicker than water, does not hold true of oceans.

The appeals that have been made in recent times to ethnic antipathies and ethnic sympathies for the purposes of political propagandism or the promotion of personal ambition are anachronistic attempts to resuscitate the tribal spirit under new forms and on a larger scale by a perverse and pseudo-scientific application of the results of comparative philology to public affairs. The hobby of

Napoleon III concerning the unity of the Latin nations, and the necessity of their closer confederation under the hegemony of France, was, like his Life of Cæsar, an act of historical self-justification, a desperate endeavor to explain his own *raison d'être*, and thus set up a temporary prop to a rickety and rootless dynasty.

Panslavism may continue, for a time, to please the imagination and to fire the zeal of a people so peculiarly subjected, in many respects, to primitive social conditions and so powerfully swayed by primitive ideas as are the Russians; but Germany has long since outgrown the swaddling-clout of Panteutonism, and no ranting of anti-Semitic agitators and men of that ilk about *ur-deutsch* and *rein-deutsch* can permanently affect the public mind or elicit a favorable response in legislative enactments.

There is no cry so foolish or pernicious that it will not find a ringing echo in the empty brain-pan of some fanatic, no whimsey so silly and absurd that it will not be caught up and preached as a new gospel of universal redemption by a few pamphleteering demagogues or ill-balanced apostles of reform. Impecunious owners of poorly furnished and tenantless garrets are only too ready to let them to the first vagrant that knocks at the door, however seedy his appearance and doubtful his repute. Even the anti-Semitic crusade, so far as it has succeeded in getting a hearing and making any headway among sensible persons, has done so by appealing to the liberal spirit of the age and representing itself as a protest against the tribal exclusiveness of Judaism.

The constitution of the aboriginal tribe as a compact body of kinsmen, animated by feelings of hostility toward all other tribes, necessitated the intermarriage of blood-relations. If, on account of scarcity of females, or for any other reason, a man desired to wed a woman of another tribe, instead of wooing her as a friend, he waylaid her as a foe, stunned her with a blow of his war-club, and carried her off as booty rather than beauty to his camp, where she served him henceforth, not so much as his companion and helpmate as his slave and beast of burden.

Even after this tribal exclusiveness and isolation had ceased and a certain amount of amicable intertribal intercourse had grown up, it was still deemed more virtuous or, as we would say, more patriotic for a man to marry his own kin than to take his wife or wives from an alien people. The tribal religion also lent its special sanction to such nuptials. Survivals of this sentiment are found in the ancient customs and in the sacred scriptures and traditions of many nations, especially in the Orient.

Thus, in the Avesta, a marriage of next of kin (*quaêtvadatha*) is declared to be particularly praiseworthy and well-pleasing to Ahuramazda, the Good Spirit (Visparad, iii, 18). This "kinship-union" is a prominent article of faith in the Mazdayasnian creed

(Yasna, xiii, 28); and in the Book of Ardâ Vîrâf (ii, 1, 2) Vîrâf is said to have had seven sisters, who were to him as wives (*chîgûn nêshman*), and this circumstance is adduced as evidence of his extraordinary piety. The connubial relations of this model of a religious man were both polygamous and incestuous.

Herodotus states (iii, 88) that Cambyses, the son and successor of Cyrus, was wedded to his own sister Atossa; and when, in the Hebrew story, Tamar rebukes Amnon for his guilty passion and tells him that "no such thing ought to be done in Israel," she refers solely to her brother's folly and wickedness in seeking a secret and illicit connection, and suggests that, if he will only speak to the king on the subject, there would be no obstacle to their union. That such marriages were common in the earlier history of the Jews is evident from the fact that Abram took to wife his half-sister Sarah, and this event is not recorded as an unusual occurrence.

Among the Persians this custom seems to have been confined, for the most part, to priests and kings, who constitute always and everywhere the two most conservative classes of society. Thus it came to be regarded as a mark of distinction or an enviable privilege, of which wealthy persons of inferior rank sometimes endeavored to avail themselves; but there is no evidence that it remained, within historical times, a law for the entire nation or was generally practiced by the people at large. The Magians continued to wive their sisters in conformity to ancient usage and holy tradition, for the same reason that stone knives and hatchets are used in sacrificial rites and fire for the altar is kindled by laboriously rubbing two sticks together long after these clumsy methods have been superseded in secular life by steel implements and lucifer matches.

A THEORY of Dr. Maurel, of the French marine, that the Khmers of Cambodia represent the leaders of the easternmost wave of migration of the Aryan or Indo-European stock, is noticed with approval by Dr. Brinton in Science. The ruins around Ang-kok decorated with bas-reliefs of scenes from the Ramayana give evidence of their having had an Aryan culture. They are supposed to have reached Cambodia about the third or fourth century of the Christian era, having apparently come from the delta of the Ganges across lower Burmah and Siam. Even at this time most of their followers may have been non-Aryan, and the leaders rarely of pure blood. In later generations they received a large infusion of Mongolian blood from the tribes they found in Cambodia. These conclusions, according to Dr. Brinton, are borne out by a close study of the existing population and of the history and archæology of the country.

DARWIN'S theory of the formation of coral reefs is not as near obsolete as some students have supposed. It had several friends in the discussion of the subject at the recent meeting of the British Association.

NIGHT HAWKS AND WHIP-POOR-WILLS.

By Dr. R. W. SHUFELDT.

THERE is hardly a season goes by that I am not asked, by some one more or less interested in our native birds, "What is the difference between a night hawk and a whip-poor-will?" Generally the belief is that these two very interesting forms are one and the same species; but this is by no means the case, and a full reply to the question leads us to the consideration of one of the most attractive groups in the entire range of our American avifauna. A number of years ago the writer made a very careful study of the representatives of this family as they occur in our country, and some of the more important facts as brought out by that research will be set forth in the present article. Those most familiar with the habits and anatomical structure of night hawks and whip-poor-wills and their allies place them in a suborder *Caprimulgi*, which primarily presents us with a family *Caprimulgidæ*, which family in the United States contains at least the four very distinctive genera *Antrostomus*, *Phalænoptilus*, *Nyctidromus*, and *Chordeiles*. To the first-named genus belong the true whip-poor-will (*A. vociferus*), together with Stephen's whip-poor-will, and the chuck-will's-widow of the Southern States, with others. *Phalænoptilus Nuttalli*, the interesting little poor-will of the Western States, is found in the second genus, while *Nyctidromus albicollis* is representative of the third. Finally, in *Chordeiles* we have the night hawks, as the common form, *C. virginianus*, as well as the Western night hawk, the Cuban night hawk, and the Texan night hawk (*C. texensis*).

To start with these it will be seen that our night hawk and our whip-poor-will belong to two very different genera of the *Caprimulgidæ*. Not only is this the case, but these two birds are in habits and in structure more widely separated from each other than is the whip-poor-will from any other genus of the family. Indeed, night hawks are quite aberrant types, while, as a matter of fact, none of our United States caprimulgine birds give us any hint of the extraordinary foreign representatives of this suborder, some of which will be referred to further on.

Upon comparing a night hawk with a whip-poor-will we find that, apart from the very well defined difference these birds exhibit in their internal structure and in the general tone and markings of their plumage, there are a few external striking features that ought to enable any person to distinguish one from the other at the most casual glance.

I refer especially to the long, conspicuous bristles projecting from about the mouth of the whip-poor-will, a character almost

entirely absent in the night hawk. Further, the tail of the former is very much rounded, with its four middle feathers like those of the back, the three outer ones, on either side, having their terminal halves *white*. In the night hawk the last-mentioned portions are *black*, and the form of the tail is very different. Our night hawk also has a distinctive white patch on the outer aspect of each wing, which is not present in the whip-poor-will. Again, the habits of these two birds are by no means similar. The whip-poor-will, with rare exceptions and under certain circumstances, is active and feeding from dark until daylight, and sleeps on the

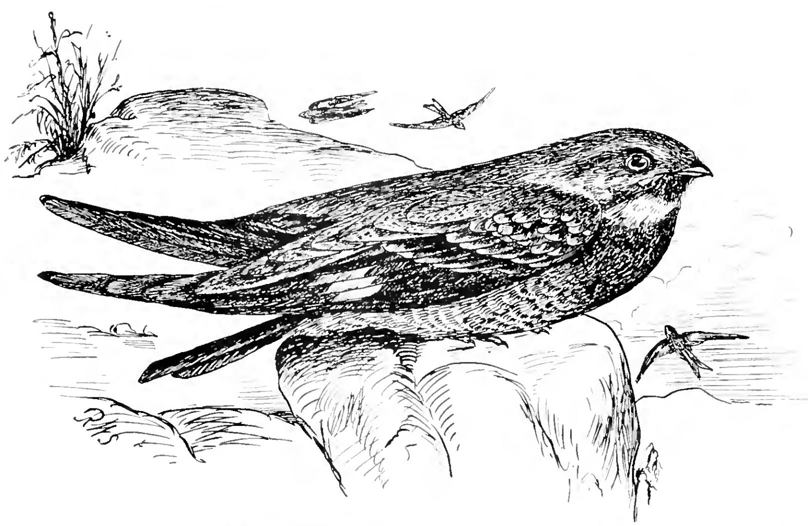

FIG. 1.—THE NIGHT HAWK (*C. virginianus*), ♂. Drawn by the author and much reduced.

ground in the forest all day, the very reverse of this being the case with the night hawk. In some localities the latter is known by the name of the "bull bat," the first word undoubtedly having reference to the booming noise it emits during its plunging freaks through the air, in which it indulges while out abroad for food. Audubon and Wilson disagreed on the score as to how this noise was produced by the bird, the former claiming that it was performed by the wings, and the latter that it was "doubtless produced by the sudden expansion of his capacious mouth." I am inclined to the opinion of Audubon in this matter.

Among our native-born Americans I have never heard the name of goatsucker applied to our whip-poor-will, whereas that is a very common appellation for the species in many parts of Europe, where still all manner of crimes are accredited to this very harmless bird—that is, to its European congener. It is now, of course, an old story that long, long ago the goatherds of Italy and Greece, observing those birds at dusk flying around the

goats among their hilly pastures, and associating this fact with the known gaping mouth of a *Caprimulgus,* soon put the scandal on foot that they suck the teats of the animals, and thus rob them of the milk. That ancient philosopher Aristotle also believed the story, and enlarged upon the legend when he wrote that the "bird called *ægothelas* is a mountain bird, a little smaller than the cuckoo. It lays two or three eggs, and is of a slothful nature; flying upon the goats, it sucks them; they say when it has sucked the teat it becomes dry, and the goat becomes blind."

That charming naturalist White, of Selborne, did much toward breaking down this kind of rank superstition, informing us, as he has, that "the country people have a notion that the fern owl, or churn owl, or eve jay, which they also call a *puckeridge,* is very injurious to weanling calves, by inflicting, as it strikes at them, the fatal distemper known to cow-leeches by the name of *puckeridge.* Thus does this harmless, ill-fated bird fall under a double imputation which it by no means deserves: in Italy, of sucking the teats of goats, whence it is called the *Caprimulgus,* and with us, of communicating a deadly disorder to the cattle. But the truth of the matter is, the malady is occasioned by a dipterous insect, which lays its eggs along the chines of kine, where the maggots, when hatched, eat their way through the hide of the beast into the flesh, and grow to a very large size." Another name for this European goatsucker (*C. europæus*) is the "night-jar," and a popular writer on the natural history of the class thus accounts for its origin: "The jarring sound, which gives name to the bird, is uttered sometimes while flying, but usually when it is at rest; it seems to be produced in the same manner as the purring of a cat, and resembles it, though much louder. One of them, emitting this sound while sitting on the cross of a small church, communicated a sensible vibration to the whole building." (I doubt that that story will find many believers among us at the present day!)

If the accounts of the habits of such gentle creatures, as recorded by men, have passed, in time, through the various stages of traditional superstition, myth, and inaccuracy, to one of enlightenment, fact, and exactness, it has been none the less so with the various ideas of natural historians in the matter of their opinions as to the place occupied in the system by the *Caprimulgi.* One chapter is quite as full of interest as the other. More intelligent observation has cleared and is clearing away the mist that enshrouded the first, while this, combined with modern methods of scientific research, is rapidly rectifying the latter. Erroneous classification, in other words, is being corrected through the steady progress of our knowledge of the morphology or structure of the class *Aves.* From an evolutionary point of view such changing

taxonomical advances stand among the most engaging of all lessons to the philosophic ornithologist. External appearances, it has taught among other things, are by no means a safe guide to the orderly classification of any series of objects. Some old works upon my library shelves, formerly considered "standard" and "classic," contain many chapters in those premises which are highly instructive on this point. One of them now open before me places, according to its author, such utterly diverse bird-groups as the trogans, the kingfishers, the swifts, the goatsuckers, and the humming birds, all among the *Passeres*. Linnæus and a number of his successors had no better appreciation of the truth, for the scientific light shed over such fields was to them still quite dim. He placed, with all confidence, the *Caprimulgi* in his order *Passeres*. Later, this created the usual intelligent, incredulous smile of the scientific taxonomer, and in the next epoch we find in their writings an "order" created to contain, among other types, the swallows, the swifts, and the goatsuckers! Then, too, think of Huxley, who as late as 1867, upon osteological grounds made a division *Cypselomorphæ*, to which he restricted the swifts, the humming birds, and the goatsuckers. A decision of that kind coming from such an influential quarter has carried with it the weight of conviction to the minds of our most recent ornithological writers and systematists. And we find Elliott Coues, in his last revised edition (1890) of his Key to North American Birds, still adhering to the old order *Picariæ*, in the first group of which, the *Cypseliformes*, he places the swifts (*Cypselidæ*), the goatsuckers (*Caprimulgidæ*), and the humming birds (*Trochilidæ*). But a far more unnatural grouping is seen in the Manual of North American Birds, by Mr. Robert Ridgway, where an order *Macrochires* is retained to contain the goatsuckers, the swifts, and the humming birds, and in this he is followed by the check list of the American Ornithologists' Union. What special kinship the systematist sees between a humming bird and a whip-poor-will, the morphologist in these days certainly fails to appreciate. Anatomically the writer has examined in great detail several species of different genera of both humming birds and goatsuckers, as he also has many swifts and swallows, and is of the opinion that the *Caprimulgi* are most nearly related to the owls, while the swifts are but profoundly modified swallows. To thoroughly appreciate such affinities it is necessary that we should have before us the so-called "outliers" of the various groups just named.

Representatives of the suborder of birds, United States species of which we are here considering, are found in many parts of the world, though they appear to be entirely absent from the avifaunæ of Polynesia and New Zealand. In South America, in Asia, in Africa, and in Australia we meet with goatsuckers of the most

varied kinds, both in the matter of form and plumage. One of the most evident types exemplifying the kinship between the *Caprimulgi* and the owls is the extraordinary species found in the caves of Caripe in South America and in Trinidad. This is the well-known "oil bird," the *Steatornis caripensis* of science, and also called the *guacharo* by the natives, who enter every season the caves where it breeds to collect the young. This is done to obtain the grease by trying out their fat-laden bodies, and thus the species has a certain economical importance. In its structure *Steatornis* is much like some owls, and its two to four white eggs, laid

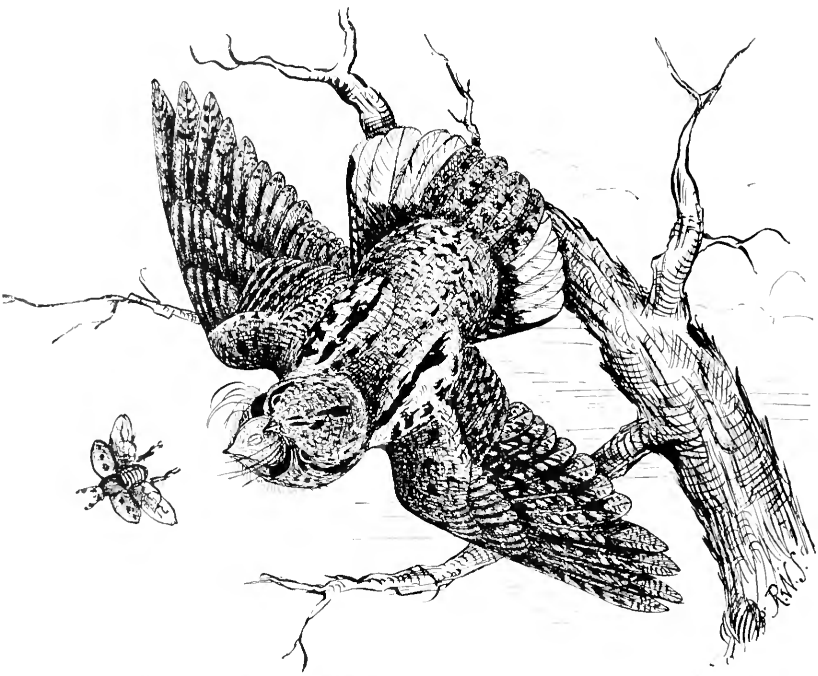

FIG. 2.—THE WHIP-POOR-WILL (*A. vociferus*), ♂. Drawn by the author and much reduced.

in a nest built by the bird of clay, closely resemble the eggs of certain birds of that group. Likewise it is nocturnal in habit, and markedly differs from the average goatsucker inasmuch as it feeds upon fruit and certain oily nuts. Structurally it has been examined with some care by the British anatomist Garrod, who fully appreciated its relation to the owls. Well it may be said that most owls have long legs which they can use to full advantage, which our night hawks and whip-poor-wills do not possess, those members being so short in them that they can only shuffle over the ground with difficulty. Yes, but there is also a Central and South American species of goatsucker, with legs so long that it can run upon *terra firma* with all the swiftness and ease of one of

our peculiar little burrowing owls of the Western prairies (*Speotyto*). Again, it is said that such owls as our screech owls (*Megascops*) exhibit a dichromatism of plumage, being "rufous" in one and, when adult, "gray" in the other, and that they have "ear tufts" or plumicorns ornamenting their heads. Here it is interesting to know that in the Malay Archipelago and in China we meet with the goatsucker *Lyncornis,* which is also characterized by the possession of "aural tufts" and a dichromatism of plumage —the same species having been taken in both a rufous and a gray one. And so we might pass from one species to another, gathering one habit here, and another point in anatomical structure there, until the most skeptical person in the world would at last be convinced that the two groups (*Caprimulgi* and *Striges*) were in some strange way related.

Plumicorns are also possessed by the remarkable Indian caprimulgine bird *Batrachostomus,* a species which also occurs in the Malay Archipelago, and still other very curious genera of other parts are the *Nyctibius* and *Ægotheles* and *Podargus; Podargus cuvieri* being fully three times as large as any known North American species of goatsucker, being found in the island of Tasmania. where its peculiar cry has caused it to receive the name of "morepork" by the colonists of that distant quarter of the globe. But for the greatest oddities among these birds, especially in the matter of plumage, we must turn to Africa, and that paradise for the explorer, Madagascar. For instance, the *Macrodipteryx* of Africa has the *ninth* primary feather of either wing developed to a pennant-like length, and when the bird is seen during flight these appendages float out in the most striking manner; being still more peculiar in an allied species where the shaft of these elongated feathers is naked, and it is only at their extremities that a spatulate form of the web is retained. Madagascaran species exist that even have still more remarkably developed wing feathers, while in the South American *Psalurus,* again, it is the lateral tail feathers that are greatly lengthened.

In concluding this brief paper I would invite attention to the fact that we find the family of goatsuckers immediately following the family of owls in Audubon's Birds of America, and of the former he observes that they are "very nearly allied in some respects to the owls"; and I am strongly inclined to the belief that that "careful dissector of birds," the "Scotch anatomist" William Macgillivray, had much to do with bringing the mind of our distinguished Franco-American ornithologist to that opinion.

RECENT RAILROAD DISASTERS.

By LAFAYETTE C. LOOMIS.

THE frequency and the frightful fatality of recent railroad disasters have come to be most appalling. Among the more prominent causes put forth in explanation or in extenuation is that of the overtaxed and exhausted condition of the trainmen. This excuse, while reluctantly accepted in part by the public, is little better, however, than none at all, as, so far as it is valid, it simply transfers the responsibility from the trainmen to the officers, and substitutes criminal mismanagement for criminal carelessness.

But this statement by no means meets the case.

Among some of the most sanguinary that come to my mind at this moment—the calamity of the Wabash, the Chester Bridge, the two on Long Island, and not long since at Yonkers, at Germantown, and near Dedham—with none of these had fatigue anything whatever to do. The men responsible for these calamities were comparatively or altogether fresh.

That the men forgot, or were careless, or inattentive, or neglectful, is true; but that in these and in many other cases, the men were overtaxed and exhausted is not true. Some other and more comprehensive cause of these oft-recurring calamities must be sought.

The science of railroad transportation, to whatever extent it has advanced, has been almost wholly the result of experiment rather than of theory. From first to last the theories, for the most part, have proved very wide of the actual results. Nor is this a matter of surprise when we consider what a revolution the locomotive wrought among mankind.

As the successor of the stagecoach, steam travel was inaugurated upon the general principles which that earlier mode of travel had evolved from long years of experience. The steam road in all its multitudinous appendages was cast to meet certain supposed requirements as to speed and volume of traffic. The roadbed, ties, rails, engines, and cars had all been calculated to meet a certain assumed pressure, strain, wear and tear. Such, however, was the almost immediate demand for larger facilities, that hardly had the various appliances of the road become adjusted to each other and their new conditions, before the extension and enlargement of the road in all its capacities had become imperative.

It was not difficult to construct an engine with greater steam capacity, and hence greater power and speed; but what a series of calamities followed! The roadbed, the ties, the rails, the wheels, were all disproportionate and inadequate.

Who that recalls the railroad conditions of forty years ago does not remember the constant succession of misfortunes chargeable to the single track, the imperfect bed, to broken rails and wheels, and a hundred other imperfections in machinery and the necessary appliances?

All these mishaps and catastrophes were a part of the new conditions men were seeking to master.

Not only was the whole scheme new to mankind, but the burden at once thrown upon it was utterly beyond its design or its capabilities. No one was more keenly alive to the inadequacy of these first plans to meet the public want, than were the railroad men themselves. But an enterprise involving millions of dollars in a definite, precalculated system is not like a garment that can be thrown aside and replaced by another at pleasure.

However desirable, the abandonment of existing conditions and the adoption of others must necessarily be slow in enterprises of such magnitude and expenditure.

Nevertheless, during those forty years, such was the mastery of general principles and detail in the construction of the road and the rolling stock, and such the perfect adaptation of part to part, that to-day failure—i. e., so-called accidents—pertaining to either of these particulars is rare.

During these years experience met each weakness as it became apparent, until now a first-class road runs thrice the weight at thrice the speed with almost entire immunity from casualty from these causes. The "accidents" of the earlier years have been well-nigh eliminated from our modern train.

But "accidents" yet remain no less frequent than in those days of inexperience. This undreamed-of accession of power and speed has also brought a larger range of liability, new conditions, and new perils.

In the earlier mishaps the fault was found to exist mainly in our want of knowledge of the innate strength of the materials used—a fault inseparable from our inexperience. In our later "accidents" the fault has not been found in the material nor in the structure. Quite otherwise.

In that frightful Yonkers calamity the fault was found to be in "the man." In the two Long Island wrecks, in the Dedham, the Chester Bridge, in the Wabash, the Germantown, and so on almost without variation, the fault has been in "the man," not in the road.

That is, in the development of these immense steam forces we appear to have reached a point where the brain force undertaking the guidance and control has become the fault-bearing element and the more fruitful cause of calamity. And so manifest has this preponderance become, that it calls for the most serious consideration.

In general terms, the brain force in our modern rapid transit, seems incommensurate with the demands laid upon it.

A fast Atlantic steamer has ordinarily, for fair weather, three or more men on watch, and two officers on the bridge; and in thick weather often not less than ten or twelve, whose sole business it is to guard the ship against outside contingencies.

We start out an express at four times the speed in equally thick weather, under the care and direction of a single man—in a few cases, perhaps, with an assistant.

Let us note the ordinary duties of this man with hundreds of lives in his keeping, plunging into the darkness, storm, snow, and fog at a speed of sixty to ninety miles an hour.

He is supposed to stand with his hand upon the throttle, looking to scan every rod of his fast-flying track, to note every crossing, every approaching vehicle, every straying animal, to observe every signal and every switch, while there are beside him in his cab from fifty to seventy-five levers, valves, cocks, gauges, handles, and what not, which he is expected to apply instantly as the exigency may arise, as danger may spring into view, or calamity confront.

It is said that Wellington, at a critical moment of Waterloo, when a message was brought to him that a certain battalion was without ammunition, failed to respond to the call. Afterward, referring to his failure and to the disaster which resulted to the battalion, he said: "It is true; but no man can think of everything."

In the heat and stress of battle a man may be pardoned an inability to recollect, even at the cost of human life; but a system of business that, every hour of the day and night, intrusts the lives and safety of the public to the care and protection of a brain overburdened and distracted, like that of a locomotive engineer, is open to the gravest criticism.

Nor is it in the duties of the engineer only that this peril abides. The Yonkers disaster, and one of those on Long Island, were from the rear; the Wabash and the Germantown from the siding. It thus appears that the demands of the modern train are insufficiently met by the intellectual guiding force at all points—front, rear, and on the sides.

The New York World in a recent article approached this question under the title of "A Psychological Puzzle." Referring to the Wabash switchman, the article says: "What made that brakeman turn the switch and let the express train plunge into the waiting freight? The accounts all agree that Thompson was a man of experience, a trusted man, and of more than ordinary intelligence. He had frequently stopped at the same siding to let the same train go by. . . . Why did he do it? Not to wreck the

train and kill the passengers. His mind wandered for a moment, he forgot his duty, and before he came to himself the mischief was done. Carelessness is hardly a complete explanation, nor is forgetfulness. . . . Does our mental machinery suddenly fail us at times?"

The continuity of the track is ordinarily broken by a like switch every few miles. An hour's ride takes the train over a dozen such breaks, any one of which misplaced means a horror like that of the Wabash. The rear guard may at any moment, from some irregularity to his train, be called upon to hasten back with the danger signal against an on-rushing second section or a close-following train. Should he stumble amid the storm, be blinded by the snow, or should the wind extinguish his light, or should he, like Thompson, fail from some unaccountable cause, a second Yonkers would follow.

Whether the explanation suggested by the World be the true one or not, one thing is very evident in the light of our modern experience, and that is, that such responsibilities as now attach to the trainman of a modern express, whether it be engineman, switchman, or brakeman, ought not to be longer intrusted to the protection of any single mind, however faithful, however conscientious. Were the human mind and body perfect as a machine, faultless in its workings, and with no liability to irregularity, failure, or lapse, we might be so justified. But, not to speak of the body, no mental organization is perfect. Frailty is a part of man's inheritance. Against that frailty, against that fatal moment, we have now no protection whatever. We are abandoned by our sole guardian, by the only divinity that stands over us, and we are left to a horrible death or to the tortures of hell. It is idle to say these men are careless, that they are regardless of duty. They are as faithful and as trustworthy as would be any other men put in their places—as faithful as our human nature permits.

It simply appears that we have been attempting to force from our human organization a degree of exactitude in the operations of the mind which the brain refuses to yield. And in view of the sanguinary record of the few past years, directly at the hands of the men in charge, we may well question the wisdom of a longer trial. It no longer remains an uncertainty where the weakness of our present system lies, where the danger abides. That the brain power of a modern express is disproportionate to the requirements, admits no further question. Safety in land travel, no less than in ocean travel, demands a duplication of the officers in charge. Whether it be engineman, rear guard, brakeman, switchman, or whoever undertakes to stand between the passenger and the multiplied dangers of the road, there should be a first and a second officer, that, in any and every emergency, whether through care-

lessness, forgetfulness, or lapse of conscious thought, the duties of that post should be sustained.

Does any one for a moment suppose that, if there had been a second officer whose business it was to inspect that Wabash switch and see and certify that it was properly set, or that if the Yonkers brakeman had been followed by a second signal light fifty yards in the rear, either of those catastrophes would have occurred, or any of these recent rear-end and siding calamities?

When, ordinarily, human life is taken, the whole machinery of the criminal law is exercised to bring the offender to justice. But here a score of persons are put to death, or to a torture the like of which exists not elsewhere in any portion of our globe, either civilized or savage—torn, mangled, crushed, scalded, burned—and it is held excusable as an "unavoidable accident."

To say that these things are a necessary part of the progress of mankind is a libel on civilization. To declare them unavoidable accidents is, for the most part, to assert that which is not true—to attempt a justification through what we know to be false. Accidents they are not. They are simply criminal maladministration.

When one's life is sacrificed, or when one is maimed for the remainder of his miserable years, it is of little import to the sufferer or to his family whether it be the result of criminal intent or of criminal neglect. The shade of difference is not so very clear between life needlessly taken and life purposely taken.

Since the foregoing was written, the death-angel has pursued his appalling railway harvest with unabated fury, seventy-seven deaths and one hundred and eighty-four mangled in thirty days, being the record for the United States, so far as heard.

From the general facts as given in the public prints, these calamities, like those above referred to, and like the most of those now occurring, appear to be attributable to "the men" and not to "the road." There have also appeared in the public press some explanatory or apologetic statements from officers of several roads, some of which are worthy of attention as expressing the views of the officials into whose care the public intrusts its welfare; none of which, however, give it any assurance of any greater degree of safety.

An officer of the New York, Lake Erie, and Western is reported as saying, "I can not explain the unusual number of accidents just now"; adding, however, "the train-dispatcher's duties have become very much more exacting." This means, if it is intended to mean anything, that the fault lies in the train-dispatcher, not in the road or machinery.

One of the superintendents of the New York Central says: "Railroad accidents are like epidemics; they can no more be fore-

told or arrested (prevented ?). . . . When a train is on a double-tracked road, the danger is reduced, I may say, one hundred per cent."

The first statement of this superintendent, if spoken hastily, without thought, may be excused as a careless utterance; but as a deliberate opinion that this railroad slaughter is not preventable, and that there is nothing left for the public but to submit to its continuance, it is simply atrocious and worthy of a savage of the Congo.

Such a statement from a railroad official, into whose hands we must perforce place our lives and those of our wives and children, is ample ground for impeachment. It makes one's blood boil.

It is to put up a sign over every station entrance on the New York Central: "Slaughter permitted here. Accidents can not be prevented." Yet, in the next breath, this superintendent adds "Double-tracking the road reduces the accidents one hundred per cent" (*sic*).

It seems, then, that one hundred per cent of the accidents were not only preventable, but that on the New York Central they had been so prevented. When the road was the source of danger, the weakness was met and overcome by re-enforcing the road. Now that the weakness is found to reside in the men, the slaughter of to-day makes an imperative demand for an augmentation of the forces, at the present moment, so inadequately and disastrously attempting control.

EVOLUTION IN PROFESSOR HUXLEY.

By St. GEORGE MIVART, Ph. D., F. R. S.

SO many adventures of gods and heroes, alternately defeated and restored, with so many other myths of earlier religions, merely (we are told) describe, in figurative language, the simplest physical phenomena, that most of us now expect to find "the dawn," or "sunset," latent in every one newly met with.

Our fairy tales also may be similarly treated, but most of them will also serve to represent, under an allegory, notable events or circumstances of human life.

The history of that gentle animal, beloved of our childhood, the White Cat—an enchanted princess, doomed to bear that feline form till freed, through the loss of head and tail, by the sharp sword of her royal lover—admits such an allegorical interpretation.

Some learned professor might tell us its real purpose was to show that pain and loss can serve to restore a noble soul, deformed by evil influences. He might also enlarge upon the text, describing how the spellbound maid herself demands the blow, and point

out we ought to learn from this that our higher aspirations should bid us brave death itself if, by a voluntary martyrdom only, we can so hasten on the triumph of "the good, the beautiful, and the true."

But this transformed princess, as also the Sleeping Beauty, Riquet with the Tuft, and Beauty and the Beast, all may alike serve to image forth an aspect of the Cosmos which is particularly interesting to us to-day. They all indicate, by some astonishing transformation, how every one and everything is affected through new conditions of environment, how change pervades the universe, and how all of us must undergo a process of evolution, though not, by any means, one in the entirely beneficent direction, nor with the rapidity these fairy tales indicate. But rapidity is essentially a relative term; and so the swift sword-stroke of the one prince or the awakening kiss of the other can quite well symbolize the slow, as well as rapid, processes of the natural world.

That universal and unceasing process of change which goes on throughout the Cosmos must affect the mind as well as the body of every one of us. Nor could a reasonable man wish that it were altogether otherwise with him, since "to cease to change is to cease to live." But we naturally shrink from decay, and should do so from mental degradation, while evolution (as above said, and as every one knows) is not universally or necessarily beneficent. Among the many evils around us (the existence of which none but an irrational optimist will deny) are the results of evolution in certain minds—minds which, in the battle of life, have become more and more morally degraded and intellectually darkened, and so continue till the end.

We might, in truth, put forward as an argument in favor of a brute element in our being, the fact that increasing years so often fail, in men as in monkeys, to produce any visible increase of "sweetness and light." On the other hand, we are most of us fortunate enough to know men in whom long life has served to ripen the most precious mental fruits.

It is the process of evolution in the mind which should above all things interest us. The great cosmic process considered as evolving suns and planets and bringing forth vegetal and sentient life is of course a wonderful and admirable process. Yet it is nothing to the formation of a single self-conscious being. So far as our knowledge extends, it is true that

> "In Nature there is nothing great but man:
> In man there is nothing great but mind."

Phases in the development of one human intelligence must therefore form a really nobler object of study than that of myriads of stellar orbs devoid of intellect.

But if mental processes should be thus interesting, *a fortiori* should they be so if they are those of a great expositor and apostle of the doctrine of evolution itself. Above all ought they to concern us if that expositor exercises great influence, is looked up to by multitudes of disciples, and has been in the habit of coupling with his expositions, precepts respecting matters which most of us think extremely important.

These considerations lead me to think that the time has come for some one to say a few words with respect to the process of evolution which seems to have taken place in the mind of Prof. Huxley. I venture, therefore, on the following observations.

Though it can not be affirmed that any sharp edge of criticism has transformed him as the sword-blade transformed the enchanted princess, nevertheless some changes of aspect are, I think, to be detected in certain of Prof. Huxley's recent utterances.

To these I desire to call attention, since they appear to justify the hope that ripened experience and mature reflection have called forth statements which, if (as is possible) they do not denote any consciously changed views, must surely, at the least, indicate their latent presence.

There are two matters with respect to his last publication * especially noteworthy: (1) The first of these concerns our ethical perceptions; the second (2) relates to the nature of man as contrasted with that of other organisms.

Besides these matters, I would also refer to certain corollaries which, in my humble judgment, result from the views he has put forward with respect to humanity and ethics.

The present inquiry is no hostile one, but is made in a spirit of sympathy—such as a decade of pleasant memories should occasion. Long ago,† and also recently,‡ I said, "No one, I believe, has a greater regard for Prof. Huxley than I have, and no one is more convinced than I am of the uprightness of his intentions and his hearty sympathy with self-denying virtue."

If I may have the great satisfaction of finding that, as to ethical perceptions, he has approximated to the standpoint I long ago advocated, that satisfaction will be free from any taint of triumph. I am far too keenly aware of my own past difficulties to wonder at another intellect having been obscured by clouds which so long overshadowed my own. Indeed, the clearing away of those obscurities is indirectly due to Prof. Huxley himself. Such is the case, since it was in that lecture room in Jermyn Street—where, owing to his kindness no less than his ability, I gained much of the biological knowledge I possess—I made the

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* The Romanes Lecture, 1893. † Contemporary Review (January, 1872), p. 196.
‡ Essays and Criticisms (Osgood, McIlvaine & Co.), ii, 101.

acquaintance of a dear and valued friend, whose acute intellect first taught me to fully understand in what the essence of "goodness" consists, as his virtue led me to appreciate its active exercise. But my enlightenment ultimately resulted in controversy; and, in order that my readers may be able to judge what signs of ascensive evolution Prof. Huxley has lately shown, I must briefly refer to a passage of arms which took place between us one-and-twenty years ago.

I had, in a little book, then recently published,* contended that the process of "natural selection" could never have evolved our ethical perceptions and our clear intellectual idea of "duty" as distinct from mere feelings of "sympathy," "fear," etc. I said:

These two ideas, the "right" and the "useful," being so distinct here and now, a great difficulty meets us with regard to their origin from some common source. For the distinction between the "right" and the "useful" is so fundamental and essential that not only does the idea of benefit not enter into the idea of duty, but we see that the very fact of an act *not* being beneficial to us makes it the more praiseworthy, while gain tends to diminish the merit of an action. Yet this idea, "right," thus excluding, as it does, all reference to utility or pleasure, has nevertheless to be constructed and evolved from utility and pleasure, and ultimately from pleasurable sensations, if we are to accept pure Darwinism: if we are to accept, that is, the evolution of man's psychical nature and highest powers by the exclusive action of "natural selection" from such faculties as are possessed by brutes; in other words, if we are to believe that the conceptions of the highest human morality arose through minute and fortuitous variations of brutal desires and appetites in all conceivable directions.

It is here contended, on the other hand, that no conservation of any such variations could ever have given rise to the faintest beginning of any such moral perceptions; that by "natural selection" alone the maxim *fiat justitia, ruat cœlum*, could not have been excogitated, still less have found a widespread acceptance; that it is impotent to suggest even an approach toward an explanation of the *first beginning* of the idea of "right." It need hardly be remarked that acts may be distinguished, not only as pleasurable, useful, or beautiful, but also as good in two different senses: (1) *Materially* moral acts; and (2) acts which are *formally* moral. The first are acts good in themselves, *as acts*, apart from any intention of the agent, which may or may not have been directed toward "right." The second are acts which are good, not only in themselves, as acts, but also in the deliberate *intention* of the agent who recognizes his actions as being "right." Thus acts may be *materially* moral or immoral in a very high degree without being in the least *formally* so. For example, a person may tend and minister to a sick man with scrupulous care and exactness, having in view all the time nothing but the future reception of a good legacy. Another may, in the dark, shoot his father, taking him to be an assassin, and so commit what is *materially* an act of parricide, though *formally* it is only an act of self-defense or more or less culpable rashness. A woman may innocently, because ignorantly, marry a married man, and so commit a *material* act of adultery. She may discover the facts and persist, and so make her act *formal* also.

* The Genesis of Species (Macmillan & Co.), 1871, second edition, p. 219.

Actions of brutes, such as those of the bee, the ant, or the beaver, however materially good as regards their relation to the community to which such animals belong, are absolutely destitute of the most incipient degree of real—i. e., formal—"goodness," because unaccompanied by mental acts of conscious will directed toward the fulfillment of duty.

By the examples thus given, it was surely plain that I represented the *formally* moral character of an act to reside in the *intention* wherewith it was performed, as distinguished from mere good results, and also in the goodness of that intention. This was made still plainer in my Quarterly article * on The Descent of Man. Therein, to guard against the absurdity of supposing I meant that it was necessary, in order that an action should be good, for its goodness to be deliberately thought of and reflected on, I said:

An action which has ceased to be directly or indirectly deliberate has ceased to be moral as a distinct act, but it is moral as the continuation of those preceding deliberate acts through which the good habit was originally formed, and the rapidity with which the will is directed in the case supposed may indicate the number and constancy of antecedent meritorious volitions.

Prof. Huxley reviewed † my book and this Quarterly article, simultaneously and at much length, in an exceedingly interesting paper entitled Mr. Darwin's Critics, which I strongly advise those interested in the question to read before reading my reply to it. Therein, entirely siding with Mr. Darwin, he did not hesitate to say ‡ (as to my distinction between "material" and "formal" morality):

For myself, I utterly reject it, inasmuch as the logical consequence of the adoption of any such principle is the denial of all moral value to sympathy and affection. According to Mr. Mivart's axiom, the man who, seeing another struggling in the water, leaps in at the risk of his own life to save him, does that which is "destitute of the most incipient degree of real goodness," unless, as he strips off his coat he, says to himself, "Now, mind, I am going to do this because it is my duty, and for no other reason"; and the most beautiful character to which humanity can attain, that of the man who does good without thinking about it, because he loves justice and mercy and is repelled by evil, has no claim on our moral approbation. The denial that a man acts morally because he does not think whether he does so or not may be put upon the same footing as the denial of the title of an arithmetician to a calculating boy, because he did not know how he worked out his sums.

I wondered, and I wonder still, how Prof. Huxley could have written this, he having before his eyes the passage of mine, just above cited, from the article of the Quarterly Review which he was criticising!

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* See Quarterly Review, July, 1871, p. 82; and also my Essays and Criticisms, 1892, ii, 49.

† See The Contemporary Review for 1871; and also his Critiques and Addresses, 1873, p. 251.

‡ Critiques and Addresses, p. 288.

However, my point now is simply to remark how far the right honorable professor then was from assigning "motive" as the one essential character of a good action. Most certainly, neither sympathy nor affection is always moral, and as to unconscious beneficent actions, I remarked, and repeat, How can a man "love justice" if he can not distinguish it from injustice? Can he appreciate "mercy" without knowing it?

A calculating boy who does not understand arithmetic can not be properly termed an arithmetician, whatever his automatic power of rendering solutions may be. But my opponent not only took the opposite view to this, but went still further; for he wrote: *

If a machine produces the effects of reasoning, I see no more ground for denying to it the reasoning power because it is unconscious, than I see for refusing to Mr. Babbage's engine the title of a calculating machine on the same grounds.

It would be hardly possible to imagine a better illustration of the absence of discrimination between what is merely "material" and what "formal" in reasoning; and this defect runs singularly parallel with the absence of a like discrimination—the discrimination as to motives—in the domain of ethics on the part of Prof. Huxley in 1871.

Finally, so complete was then his identification of "duty" with "pleasure," that, when attempting to assume, for the moment, the position of an "absolute moralist," he wrote: †

To do your duty is to earn the approbation of your conscience or moral sense; to fail in your duty is to feel its disapprobation, as we all say. Now is approbation a pleasure or a pain? Surely a pleasure. And is disapprobation a pleasure or a pain? Surely a pain. Consequently all that is really meant by the absolute moralists is that there is, in the very nature of man, something which enables him to be conscious of those particular pleasures and pains.

Inasmuch, therefore, as Prof. Huxley would then have said that the proper object of life is to do one's duty, he must likewise have thereby meant that its object also was to *escape from the pain and sorrow* consequent on its non-fulfillment. Such is the necessary consequence of identifying an ethical perception (a matter of intellect) with a "feeling."

But it is not a fact that every perception of duty performed, and recognized as such, is necessarily pleasurable; nor every consciousness of duty similarly violated, a painful experience.

In a perfect nature, of course, moral sentiments will always harmonize with ethical perceptions. But who is perfect? To do right is often a labor and a sorrow, and it is certainly not less meritorious on that account.

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* *Loc. cit.*, p. 281.

† P. 289.

But, unhappily, men sometimes take pleasure in acts which their conscience disapproves, and enjoy them the more on such very account. "I'm a sad dog, I am, no mistake about that!" has been said, now and again, with a pleasurable chuckle of immoral self-consciousness, by men not by any means the worst of sinners.

Real merit depends exclusively on motives, and thus one and the same act may be moral or immoral, according to the direction taken by the will in performing it—as in the instances above given of the sick nurse and the woman materially an adulteress.

But this ethical distinction between acts *formally* and only *materially* good—the distinction of motive and consequent merit or guilt—is the most important distinction which it is possible for us to draw in the whole domain of human thought, from elementary arithmetic up to the highest regions of philosophy.

The reader will readily understand then my satisfaction when, on perusing the right honorable professor's recent lecture, I read as follows: *

> Civilization could not advance far without the establishment of a capital distinction between the case of involuntary and that of willful misdeed; between a merely wrong action and a guilty one. And, with increasing refinement of moral appreciation, the problem of desert, which arises out of this distinction, acquired more and more theoretical and practical importance. . . . The idea of justice thus underwent a gradual sublimation from punishment and reward according to acts, to punishment and reward according to desert; or, in other words, according to motive. Righteousness—that is, action from right motive—not only became synonymous with justice, but the positive constituent of innocence and the very heart of goodness.

The position of the absolute moralist could not be better expressed than in those admirable words: The "very heart of goodness" lies in action due to right motives and good will.

I add the words "good will" because, with the attribution of guilt or merit to actions according to the motives of the doer of them, a certain freedom must also be attributed to the will itself. Moral blame or approbation can not (as the universal custom of mankind shows) be attributed to any being destitute of all power of choice or of any control whatever over the actions he performs. Prof. Huxley will not deny that "our volition counts for something as a condition of the course of events."

An act of free will is no uncaused event. Its cause is the spontaneous self-determination of him who freely acts.

But some noble words in the recent Oxford lecture specially merit notice as containing in them an energetic repudiation of the utilitary theory of morals. They are: † "We should cast

* [November Popular Science Monthly, pp. 24, 25.]

† [December Monthly, p. 191.]

aside the notion that the escape from pain and sorrow is the proper object of life."

I will now pass to the second of the two processes of evolution which his recent writings seem to indicate as having taken place in the mind of Prof. Huxley.

He and I worked simultaneously and harmoniously to show how much less the human body differs from that of an ape, than does that of an ape from any other animal.

In his work on Man's Place in Nature (1863), he diverged from Cuvier and followed Linnæus by including man in one order —Primates—with the apes and lemurs. In the first scientific paper I ever published,* I went yet further and reduced man (anatomically considered) to the rank of a section of a suborder of the Primates, for which section I first proposed the term "Anthropoidea."

But while the professor took the position of an entire sympathizer with and supporter of Mr. Darwin's views as to man's origin, I have ever maintained that, in spite of the closeness of bodily resemblance, the psychical gulf between him and them constitutes a profound difference not merely of degree, but an absolute distinction of kind—one involving a difference as to origin.

The position I at once assumed, which I have unfalteringly upheld, and now maintain more confidently than ever, is that no mere process of evolutionary natural selection, no cosmic process, could ever have produced from irrational Nature a being "looking before and after"—a being who could say either "this must be absolute truth," or "such is my duty and I will, or will not, do it." It was with great satisfaction, therefore, that I perused some of the passages on this subject in the recent Romanes lecture.

Therein, after having affirmed † that the mere animal man had attained his position by the cosmic process—a view I had supported ‡ in 1871—the lecturer makes the following statement: #

> The practice of that which is ethically best—what we call goodness or virtue —involves a course of conduct which, in all respects, is opposed to that which leads to success in the cosmic struggle for existence. In place of ruthless self-assertion it demands self-restraint; in place of thrusting aside, or treading down, all competitors, it requires that the individual shall not merely respect but shall help his fellows; its influence is directed, not so much to the survival of the fittest, as to the fitting as many as possible to survive. It repudiates the gladiatorial theory of existence.

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* Proceedings of the Zoölogical Society, 1864, p. 634. See also The Philosophical Transactions, 1867, p. 300.

† [November Monthly, p. 21.]

‡ See The Genesis of Species, p. 325.

[December Monthly, p. 189.]

We read also:

Social progress means a checking of the cosmic process at every step, and the substitution for it of another, which may be called the ethical process. It depends (he tells us on the next page) not on imitating the cosmic process, still less in running away from it, but in combating it.

It is yet further said: *

The history of civilization details the steps by which men have succeeded in building up an artificial world within the Cosmos. Fragile reed as he may be, man, as Pascal says, is a thinking reed: there lies within him a fund of energy, operating intelligently, and so far akin to that which pervades the universe that it is competent to influence and modify the cosmic process.

I have always maintained that the cosmic process, since it often favors the ill-doer more than the virtuous man, could never by any possibility have evolved the ethical ideal.

Prof. Huxley now bears the most satisfactory witness to this truth, saying: †

The thief and the murderer follow Nature just as much as the philanthropist. Cosmic evolution may teach us how the good and evil tendencies of man may have come about; but, in itself, it is *incompetent to furnish any better reason why what we call good is preferable to what we call evil than we had before.*

Just so! It would be difficult to declare more emphatically that ethics could never have formed part and parcel of the general process of evolution.

But with that change, whatever it may have been, which first introduced into this planet an intellectual, and therefore ethical, nature, it is no wonder that consequences thence resulted destructive of antecedent harmonies.

Many persons deplore the ravages which the one intellectual animal (man) has effected on the fair face of Nature. As a naturalist I feel this strongly, and the extinction of so many curious and beautiful forms of life which human progress occasions is very painful to contemplate. It seems to us hateful that the harmonious results of Nature's conflicting powers should be disturbed and upset to meet the vulgar needs of uncultured human life.

Yet reason should convince us that this sentiment is a mistaken one. We may, indeed, most reasonably regret the loss of species of animals and plants which greater care and foresight might have preserved; yet we should never forget that over the irrational world man legitimately holds sway, and that weighed in the balance with him the rest counts for nothing. The very poorest homestead, the ugliest row of cottages, the most common-

* [December Monthly, pp. 189, 190.]

† [December Monthly, p. 187.] The Italics are mine.

place suburb, and the manufacturer's chimney, with its grimy surroundings and furnaces which make verdure impossible, are each of them priceless in value compared with all the charms of irrational Nature which the most skillful poet can depict. They are of such value, because each is an arena wherein good thoughts and words and deeds may find a place, and so help on the world to fulfill what is for us its one great end.

A nature must be wonderful indeed which demands for its existence the reversal of that great cosmic process which, so far as we know, has ever and everywhere prevailed antecedently to its advent. The difference between a being of so transcendent a nature and every other must surely be something altogether different from the difference between mercury grass and a field buttercup, or between a wolf and a badger!

But the reader must not imagine I would represent Prof. Huxley as an entirely conscious convert to a view opposed to that he had before advocated. Some of his utterances concord with the latter, and I can not presume to say to which he will ultimately adhere.

Thus, as to the future of evolution, he tells us: *

> Some day, I doubt not, we shall arrive at an understanding of the evolution of the æsthetic faculty.

He affirms also that those who seek to find "the origin of the moral sentiments" [the right honorable professor's term for ethical perceptions] in evolution "are on the right track."

In a note † he declares that—

> Strictly speaking, social life and the ethical process, in virtue of which it advances toward perfection, are *part and parcel* of the general process of evolution, just as the gregarious habit of innumerable plants and animals, which has been of immense advantage to them, is so.

Is this only an inconsistent adherence to old opinions, or is it meant to be seriously maintained as an essential truth? If the latter, it nullifies all that was said as to the distinctness of the ethical process and the wonderful reversal of the great cosmic process by man! Every one knew that gregarious creatures, such as wolves, have different habits from solitary animals, such as badgers, and many know that the growth of mercury grass has consequences whereof that of the buttercup is devoid. No prophet need arise in Israel to tell us such things as these. No special university lecture was required to teach them to us, and I, for one, must decline to believe that all those eloquent expressions which have been quoted—respecting "righteousness being the

* [December Monthly, p. 187.]

† [December Monthly.] Note, p. 188. The Italics are mine.

very heart of goodness"; the explicit denial that evolution can teach us why good is to be preferred to evil, and the representation of the ethical combating the cosmic process—mean no more than that a difference has been established essentially similar to that which exists between social and solitary caterpillars.

I am confident that in my interpretation I can only be doing the right honorable professor justice, for who out of Bedlam would call the gregarious mode of growth of a patch of mercury grass an *ethical process?* We might just as truly attribute "calculation" to crystals, and "amorousness" to oxygen.

Of course, evolution will cause a social organism so to grow or so to act as not to destroy itself. To do this is one thing, to see that it is its *duty* so to act is quite another.

Prof. Huxley informs us * that to his knowledge no one

> professes to doubt that, so far as we possess a power of bettering things, it is our paramount duty to use it and to train all our intellect and energy to the service of our kind.

But it is questionable whether some pessimists would not only doubt, but even deny, this assertion; and it is only too plain that, without *professing* to *doubt* it, multitudes of men and women by their actions practically *deny* it. Prof. Huxley's assertion is an uncompromising "categorical imperative," and, of course, will receive the support of absolute morality; but whence does he derive such an ethical ideal? Man did not voluntarily and consciously invent it. It was *in* him, but not *of* him. To this it may be replied that only developed man has such perceptions, and that the thoughtless brains of a savage are devoid of all ethical intuitions, while every one must admit that the infant gives no evidence of their presence. But to say that because the infant does not *manifest* them it does not possess them, would be as reasonable as to say that because a field shows no sprouting corn there can be no corn beneath its surface! As to savages, I have elsewhere † stated my reason for believing they have essentially the same nature that we have ourselves. If I were wrong in this, I should not regard them as men. I should not care if it could be proved that intellect and ethical perception did not anywhere exist a hundred years ago. I know that they exist *now*, and I know that a being who possesses them is, and must be, of an absolutely different nature from one who does not. As a fact, I think few will dispute that most infants which live to adult age and many savages who come in close contact with Europeans clearly demonstrate that their "*nature*" was rational, however tardy and impeded may have been their manifestation of rationality.

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* [December Monthly, p. 187.]

† See On Truth (Kegan Paul, Trench & Co.), chapter xix, pp. 282–294.

But the advent of a being who has such faculties as man has, and whose career *really* conflicts with, and reverses the great process of cosmic evolution, may well have had an origin different in kind from that of every other animal—at least, so far as regards his intellectual principle.* For he is a being with two natures in one person, and thus it is that when we speak of "the whole of Nature," or "the natural world," a definition of our meaning is needed in order to avoid ambiguity. The term "Nature" may be used in a broad or in a narrow sense.

In the broad sense † of the word, it includes man with all his powers and their effects, while in the narrow sense of the word Nature he is excluded from it.

Much may be said for the latter use of the term, since man, by his intelligence and will, is able to change the whole course of physical causation. Thus his power, when contrasted with all the other powers of Nature known to us, may, in a sense, be termed "supernatural," and he may be truly said to "perform miracles." So great, indeed, is the contrast and distance between man and the world of irrational nature, that it suggests now, as it suggested of old, a contrast and difference on the other side—I mean, it suggested the existence of a "real supernatural"—of a mode of being which is raised above all human nature, as man himself is raised above all infra-human nature.

And so I come to one of the corollaries which I think results from such a change of view with respect to man as the words above quoted ‡ from Prof. Huxley would seem to indicate—namely, the recognition of a Divine All-perfect Creator of the world and man.

This corollary Prof. Huxley seems as yet indisposed to admit, although he has elsewhere # spoken of man as "here and there reflecting a ray from the infinite source of truth!" He is, as yet, plainly indisposed to admit it, because he declares ‖ that the exist-

* In my Genesis of Species (1871), p. 325, I said: "Man, according to the old scholastic definition, is a rational animal (*animal rationale*), and his animality is distinct in nature from his rationality, though inseparably joined during life in one common personality. Man's animal body must have had a different source from that of the spiritual soul which informs it, owing to the distinctness of the two orders to which these two existences severally belong. . . . That the first man should have had this double origin agrees with what we now experience. For, supposing each human soul to be directly and immediately created, yet each human body is evolved by the ordinary operation of natural physical laws. . . . Man is, indeed, compound; in him two distinct orders of being impinge and mingle; and with this composite nature an origin from two concurrent modes of action is congruous, and might be expected *a priori*."

† The sense used by me in my Lessons from Nature (John Murray), 1876.

‡ See p. 327.

See Man's Place in Nature, p. 112.

‖ [December Monthly, p. 181.]

ence of evil is incompatible with the existence of an omnipotent and infinitely beneficent Cause.

But, assuming the existence of evil to be to us inexplicable, we are but thereby landed in a choice of difficulties, between which, it seems to me, no rational man should for one moment hesitate.

One difficulty is the existence of a complex Cosmos, which could never have been naturally selected, and whereof intelligence and goodness (in ourselves) form part, without an adequate cause —i. e., without God.* To regard this non-theistic view as a possibility is, in my eyes, the acme of irrationality.

The other difficulty is the possible accord with God's infinite goodness, of evil, permitted for purposes we can not conceive of, and due to attributes higher than, though not inconsistent with, beneficence. How any one, who has not the presumption of pretending to understand what God is, can really find this second difficulty a serious one, is to me amazing.

Christianity can supply not only an explanation but also a profound consolation for the troubles of this life, and mere ordinary experience shows us that things we have now and then desired would, if obtained, have been baneful for us, as also that apparent evils have been blessings in disguise. Prof. Huxley, indeed, very truly says: †

> That there is a "soul of good in things evil" is unquestionable; nor will any wise man deny the disciplinary value of pain and sorrow.

On this we have often insisted; but none the less we are from asserting that ours is the best of all possible worlds. All I would affirm is that God must have created a Cosmos such as to respond most fitly to the intention of a Being infinite in intelligence and goodness, but also possessing attributes of which we can have no conception whatever.

Heartily do I echo Prof. Huxley's denunciation of the words, "Whatever is, is right," as opposed to all our noblest aspirations, and most true is his remark ‡ that—

> To the man with an ethical ideal, the world, including himself, will always seem full of evil.

But the teaching of the lecture, as a whole, is a depressing one. Many years ago Prof. Huxley taught # that in "sadness" lay "the essence of all religion," and little comfort is to be gained from his

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* As to "Natural Selection" in this relation, and as to adequacy and the eternity of the Cosmos and its Cause, see On Truth, chapter xxvi, pp. 450–499.

† [December Monthly, p. 182.] His difficulty rather concerns the merely animal world. As to this question, space does not allow me to do more than refer my readers to my book On Truth, p. 471.

‡ [December Monthly, p. 182, note.]

Lay Sermons (1870), p. 15.

latest utterance. He tells us,* "The theory of evolution encourages no millennial anticipations." This is true, indeed; and though the world's existence may seem long when measured by the span of a human life, it is but "a flash in the pan" compared with the infinite ages. And if we suppose the cosmic process to continue indefinitely, and suns with their attendant planets so to pulsate into and from separate existence, yet it promises nothing for all mankind but absolute annihilation and utter nothingness.

The Oxford lecturer, however, discoursing on truly "vain philosophy," predicts a mere recurrence of pulsations for the best human thought. Its modern form, he tells us †—

is making a fresh start from the base whence Indian and Greek philosophy set out; and, the human mind being very much what it was six and twenty centuries ago, there is no ground for wonder if it presents indications of a tendency to move along the old lines to the same results.

The human mind is, of course, very much what it was, but it has now what then it had not—the light of Christianity to aid its progress. Its influence has ground and sharpened the weapons of the intellect as they have never been ground and sharpened before. No doubt, the prejudices which have grown up under the teaching of Descartes and Locke, which have been intensified by Berkeley, and which culminated in Hume, will continue to dominate those who can not extricate themselves from that sophistical labyrinth wherein I was once myself imprisoned. The labyrinthine spell, which makes escape impossible, consists in the words: "We can be supremely certain of nothing but our own present feelings." Hypnotized by this formula, the victims fancy they can not know with certainty their own substantial and continuous existence. But the spell is at once dissolved by the recognition that such feelings are *not* primary declarations of consciousness, but simply the result of an act of reflection parallel with that which tells us of our own persistent being.‡

The dreams of Brahmanism and Buddhism, Ionian philosophy, Idealism, which may be called the philosophy of Janus,# and the noble inconsistencies of pantheistic Stoicism are all impossible for those who have come to apprehend the truths enshrined in Christian philosophy.

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* [December Monthly, p. 190.] † [December Monthly, p. 186.]

‡ It is, of course, impossible in these pages to draw out the reasons which justify the above assertion. For them the reader is referred to my book On Truth, chapters i, ii, and ix.

Because the system can readily be inverted so as to become materialism. Its materialistic face belongs to it as properly as does its idealistic visage. Prof. Huxley says [November Monthly, p. 31], "Granting the premises, I am not aware of any escape from Berkeley's conclusion." Neither am I. But I am no less unaware of any necessity to accept those premises, the truth of which I unhesitatingly deny.

It would be an important approximation toward that philosophy on the part of the second Romanes lecturer, if those words of his I have here cited signify an acceptance of the distinction between what is "formal" and what only "material" in the sphere of ethics on the one hand, and an appreciation of the essentially distinct nature of man on the other. His expressions seem to me to justify the hope that the process of mental evolution has in him had this result.

I can not, however, regard them as decisive. It may be I have been deluded by my earnest wish that those words,

> Whose faith and work were bells of full accord,

which have been said of a valued friend of us both, may one day also be said of him. If, however, I have been mistaken, I shall not on that account cease to hope that ultimately my wish will be fulfilled.

For my own part my conviction grows ever stronger that, though corporeally man is but a sort of ape, his intellectual nature is so distinct that, thus considered, there is more difference between him and the orang than between the latter and the ground beneath its feet.

But high as he is raised above the rest of Nature, the very limitations of his reason, considered in the light of the highest ethical aspirations of his being, demand something beyond Nature—a Divine revelation.

This is what the higher races of mankind seem to me to have, consciously or unconsciously, sought and striven for, from the dawn of history till the advent of Christianity. The acceptance of that revelation (of course without the surrender of a single truth of physical, biological, historical, or any other science) is, I believe, the logical outcome of the Theistic corollary implied by that power of ethical intuition which so forcibly proclaims both the responsibilities and the dignity of man.—*The Nineteenth Century.*

An incident related by Persifer Frazer in his biographical sketch, in the American Geologist, of Thomas Sterry Hunt, may be regarded as illustrating the force with which first impressions strike the mind. At the first scientific convention which the young chemist and geologist attended, that of the Association of American Geologists and Naturalists, in 1845, Dr. C. T. Jackson read a communication on the copper and silver of Keweenaw Point, and Prof. H. D. Rogers submitted some remarks on the question of the Taconic rocks, two subjects which afterward received great attention from Dr. Hunt to the last days of his life. "One might easily and perhaps profitably trace," Dr. Frazer remarks, "the origin of many investigations which Dr. Hunt has pursued to brilliant discoveries in the sometimes vague but to him suggestive questions and observations at these scientific meetings."

HOW THE SEA IS SOUNDED.

By G. W. LITTLEHALES.

IT was not until long after astronomers had begun to sound out the realms of space and to measure the distances and weigh the masses of the planets that the longing which has always existed in the human mind to know more of the mysteries of the sea began to be gratified. Indeed, the deep sea remained unfathomed and mysterious until after the second half of the present century had dawned upon the world; and the contemplative mariner of fifty years ago, as he looked upon the heaving bosom of the ocean and wondered at its mysteries, had nothing but myths and legends to sustain his meditation.

Under the stimulus created by the achievements in investigating the earth, the air, and the heavens attempts had already been made to fathom the ocean both by sound and pressure, but in what sailors call "blue water" every trial was a failure repeated.

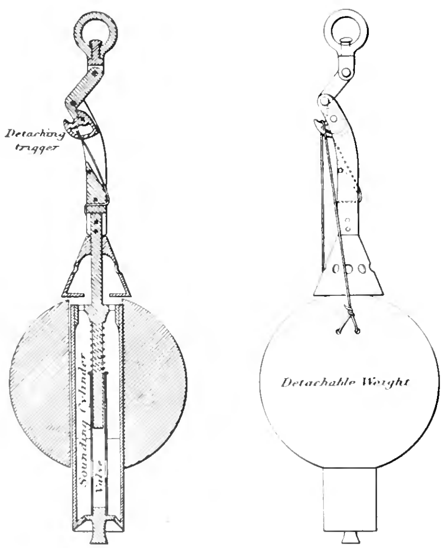

FIG. 1.—MODERN SOUNDING CYLINDER.

In 1856, Maury writes: "The most ingenious and beautiful contrivances for deep-sea sounding were resorted to. By exploding heavy charges of powder in the deep sea, when the winds were hushed and all was still, the echo or reverberation from the bottom might, it was held, be heard and the depth determined from the rate at which sound travels through water. But though the explosions took place many feet below the surface, echo was silent and the sea gave out no answer. Ericsson and others constructed deep-sea leads having a column of air in them which, by compression, would show the pressure of the water to which they might be subjected, and therefore the depth. This plan was found to answer well for ordinary purposes, but in the depths of "blue water," where the pressure is equal to several hundred atmospheres, the trial was more than these instruments could stand."

Lieutenant Maury planned and constructed an ingenious deep-

sea sounding apparatus in which there was attached to the lead, upon the principle of the screw propeller, a small piece of clock-work for registering the number of revolutions made by the little screw during its descent; and it having been ascertained by experiment in shoal water that the apparatus in descending would cause the propeller to make one revolution for every fathom of perpendicular descent, hands provided with the power of self-registration were attached to the dial, and the instrument was complete. It worked well in moderate depths, but failed in the deep sea on account of the difficulty of getting it down if the line used were large enough to give the requisite strength for hauling up.

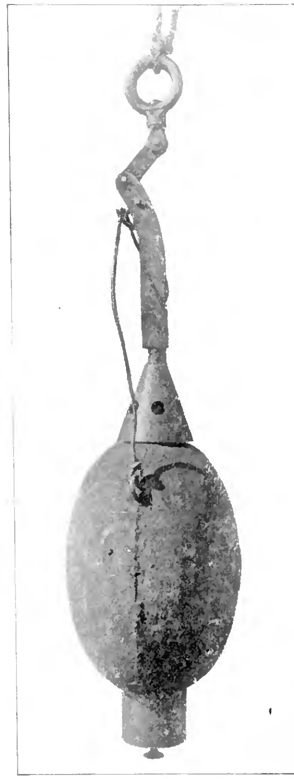

Fig. 2.—The Sounding Cylinder with Shot attached.

Such was the state of the development of the appliances for measuring the depths of the sea in the middle of the present century, when the idea of using a heavy weight attached to a simple hempen cord was proposed. The plan of stretching a line under the strain of a weight at its lower end from the surface to the bottom underlies the method which is now universally employed for sounding the depths of the sea. In shoal water there is cast from the vessel a plummet in the form of an elongated truncated cone attached to a hempen cord which has been previously divided into feet or fathoms. The line is allowed to run out through the hands of a man who detects, by the sense of touch, the instant when the lead reaches the bottom, and reads the depth by noting the division of the line which corresponds with the surface of the water. By filling a small cavity in the base of the lead with tallow, a quantity of the sand or gravel or mud upon which the lead strikes becomes imbedded in the tallow and gives an indication of the character of the bottom soil.

The rough surface of a rope presents an obstacle to its free passage through the water, and therefore as the depths increase it is necessary to employ heavier weights to carry the line swiftly in a straight course to the bottom, and, moreover, stronger rope to bear the increased weight of the sinker. In great depths the size of the rope which is necessary is such as to present considerable surface to the action of submarine currents, which carry the line

more and more out of the vertical direction in proportion to the duration of the passage of the sinker to the bottom, and render the results less and less accurate. Moreover, as the weight of the submerged portion of the rope in addition to the weight of the sinker soon becomes so heavy that a man can not lift it, and therefore can not assure himself by the sense of touch when the lead has reached the bottom; and as the weight of the submerged parts is sufficient at great depths to cause the unwinding of the reel, the line may continue to pass out long after the sinker has reached bottom, and the length unwound may thus bear no relation to the depth to be measured. In addition to these sources of error there is another arising from the drift of the vessel during the period of several hours which is required to effect a deep-sea sounding with rope.

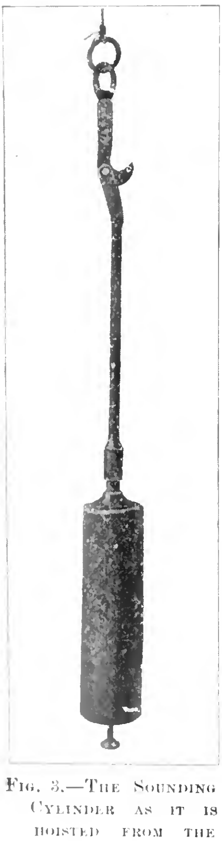

Fig. 3.—The Sounding Cylinder as it is hoisted from the Bottom after the Sinker has slipped off.

These causes, tending to carry the line off in the direction of the subsurface currents in an ever-increasing complication of loops and bends, and impeding more and more the velocity of the fall of the plummet until it sinks into the oozy soil without communicating to the surface any evidence of its arrival at the bottom, explain the reports of the vast depths of the sea that astonished the public mind less than half a century ago. Lieutenant Berryman, of the United States brig Dolphin, reported an unsuccessful attempt to fathom mid-ocean with a line thirty-nine thousand feet in length. Captain Denham, of her Britannic Majesty's ship Herald, reported bottom in the South Atlantic at a depth of forty-six thousand feet; and Lieutenant J. P. Parker, of the United States frigate Congress, in attempting to sound the same region, let go his plummet and saw fifty thousand feet of line run out after it as though the bottom had not been reached. The deepest spot in the South Atlantic is not more than twenty thousand feet beneath the rolling waves that sealed its mysteries fifty years ago; and the deepest spot yet discovered in the world not more than twenty-eight thousand feet.

By the use of wire for sounding great depths many of the difficulties and uncertainties which characterize the use of rope are obviated, for the wire, being light in weight and of small cross-section, is not greatly affected by submarine currents, but allows

the sinker to pass swiftly to the bottom. While the apparatus for sounding the sea consisted of a weight secured to the end of a hempen cord which was paid out from a simple reel on the deck of a vessel, no reliability could be attained in the measurement of depths, because the cord employed was necessarily so large as to become a controlling element in the weight of the system. But when the project for the Atlantic telegraph cable made it necessary to obtain accurate measurements of the depth of the ocean, Midshipman Brooke, of the United States Navy, took the first great step in providing means for trustworthy deep-sea sounding by inventing an implement in which the sinker, enveloping a tube secured to the sounding line, was detached on striking the bottom and left behind when the tube was drawn up.

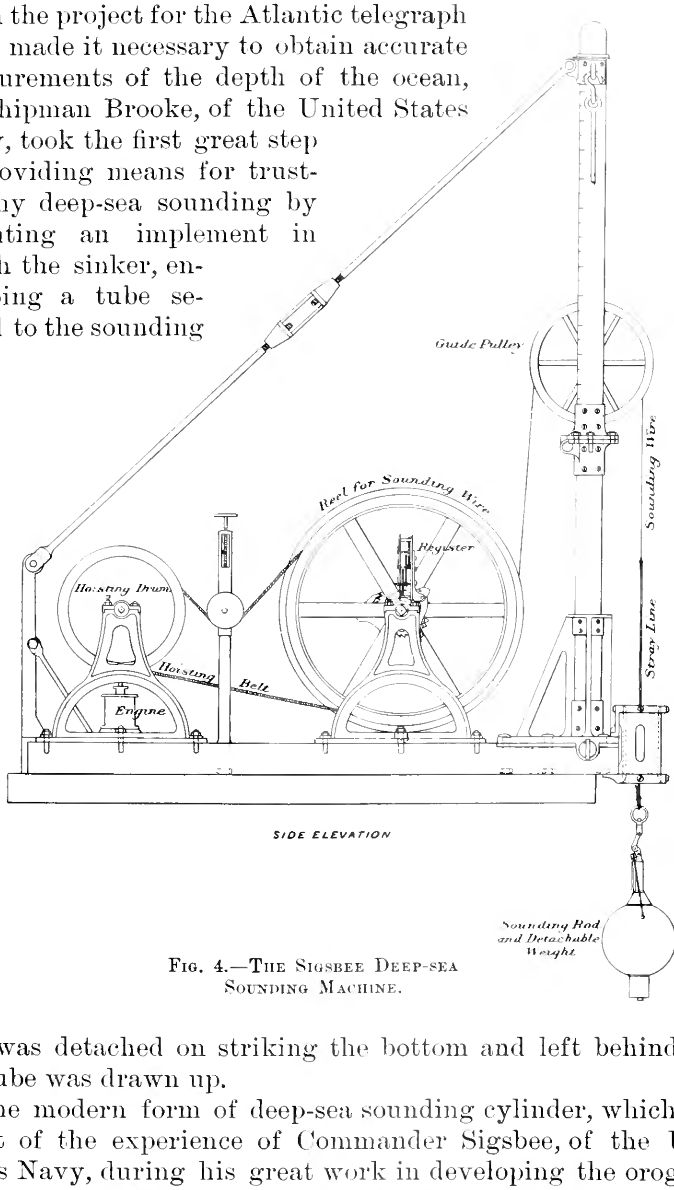

Fig. 4.—The Sigsbee Deep-sea Sounding Machine.

The modern form of deep-sea sounding cylinder, which is the result of the experience of Commander Sigsbee, of the United States Navy, during his great work in developing the orography of the Gulf of Mexico, is provided with valves at the upper and lower ends which open upward, and during the descent allow

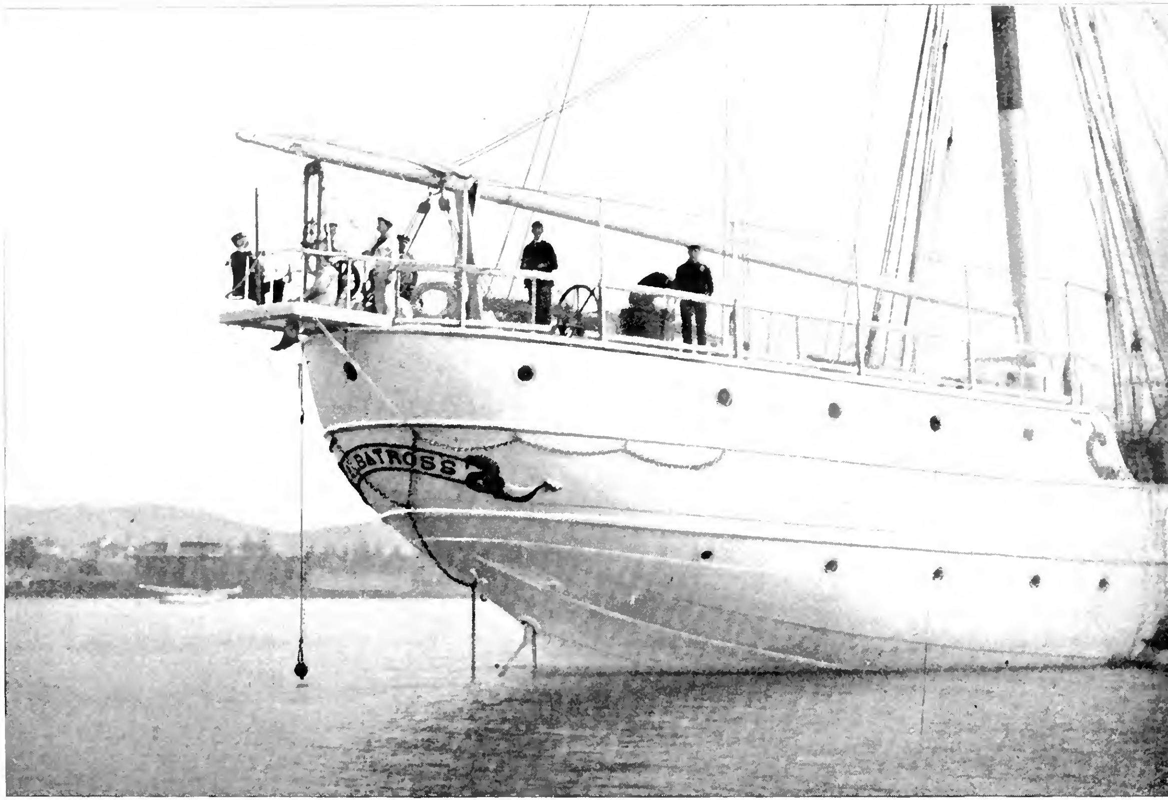

Fig. 5.—About to Sound from the United States Fish Commission Steamer Albatross.

the water to pass freely through the cylinder so that it experiences a minimum of resistance. On striking the bottom, the slackening of the sounding line, which is secured to the ring shown at the upper end in the accompanying illustration, causes the trigger to spring back and release the sling that supports the detachable weight. As the lower end of the sounding cylinder sinks into the bottom a specimen of the soil forces itself through the lower valve and lodges in the interior of the cylinder. When the cylinder is hauled up the valves at the top and bottom are closed by their own weight and the pressure of the water, and the specimen is sealed until its arrival at the surface, when it is removed for examination by unscrewing the upper and lower halves of the cylinder.

In 1872 Sir William Thomson (Lord Kelvin) succeeded in adapting piano-forte wire to successful use as a sounding line in his navigational sounding machine, and a few years afterward Commander Sigsbee, besides contributing by his inventive genius most of the smaller instruments and implements used in modern deep-sea research, achieved the crowning triumph of the art in his elaborate deep-sea sounding machine, by which, while relieving the delicate sounding wire from the sudden strains to which it would otherwise be exposed by the pitching of the ship while lying to for the purpose of sounding, the profoundest depths are measured with celerity and exactness.

In this machine the wire passes outboard from the reeling drum over a guide pulley mounted on a crosshead that works between two upright guide frames. Each of the guide frames incloses a spiral spring called an accumulator, which is connected with the guide pulley by means of a rope that passes over a pulley at the top of the guide frame. If the ship is suddenly borne upon the top of a wave while the sinker is going down, instead of causing a jerking strain upon the sounding line, the stress is communicated to the guide pulley, which moves downward under the additional load and extends the accumulator springs; and, likewise, when the ship suddenly sinks into the trough of a wave, the tendency to slack the sounding line is counteracted by a rise in the guide pulley brought about by the normal tendency of the accumulator springs to contract.

A ship regularly engaged in deep-sea sounding usually has the sounding machine mounted at the after end, and when about to sound is brought to a standstill with the stern to the sea. The stray line with the sounding rod and sinker attached is over the guide pulley and carefully lowered to the water's edge, the register is set to zero, and the deep-sea thermometer is clamped to the sounding line; a seaman is stationed at the friction line which controls the velocity with which the wire is unreeled, another at

the brake, and a third on the grating outside to handle the sinker and instruments and to guide the wire as it passes overboard; a machinist is at the hoisting engine, and the recorder takes a position for reading the register. When the sinker is let go, the vessel is manœuvred so as to keep the wire vertical, and the friction line is adjusted so as to allow it to descend from seventy to one hundred fathoms per minute. The instant the sinker strikes bot-

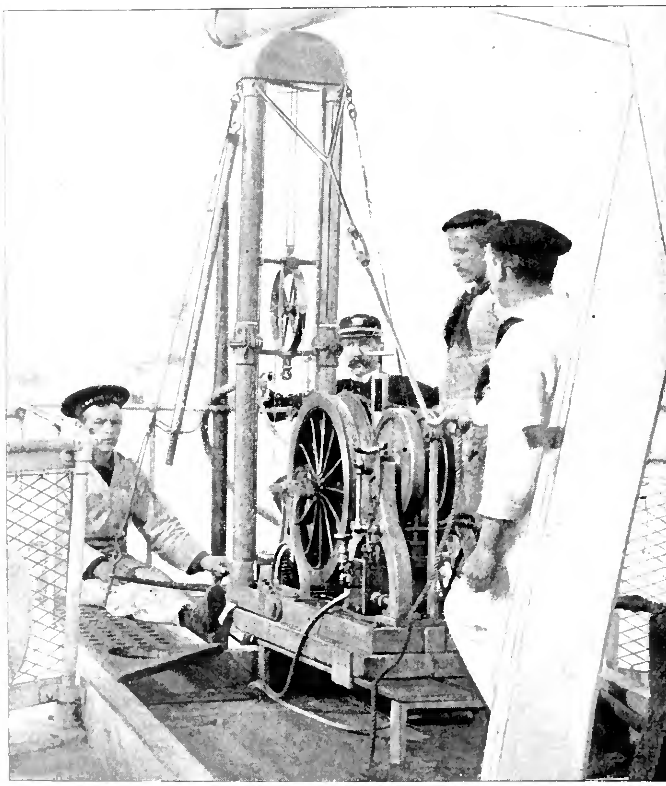

Fig. 6.—Sounding: The Sinker going down.

tom, which is unmistakably indicated by the sudden release of the wire from strain, the reel is stopped by the friction line and brake; the recorder notes the number of turns of the reel indicated by the register and determines the depth; the cranks are shipped and sufficient wire is hove in by hand to allow the end of the sounding rod to clear the bottom. Steam is then admitted to the cylinder of the hoisting engine, and the wire is reeled in slowly at first but finally at the rate of one hundred to one hundred and fifty fathoms per minute. The last ten fathoms are reeled in by hand, then the thermometer is read and the specimen of the bottom soil brought up in the sounding cylinder is examined.

In an hour this messenger of man's ingenuity makes its excursion through five miles of watery waste to the abysmal regions of perfect repose and brings to the light of day the soil with which the rain of shells of minute infusorial organisms from the upper

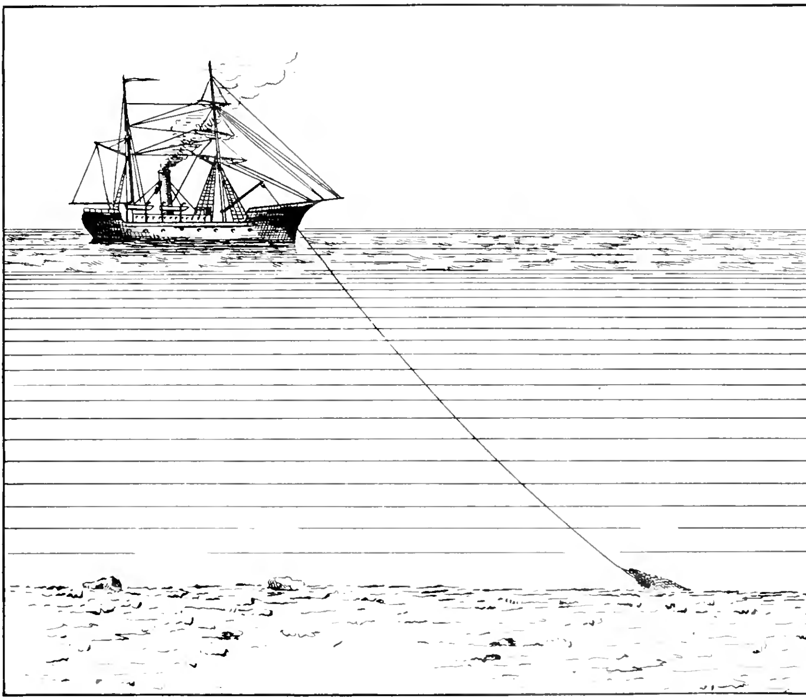

Fig. 7.—Dredging.

waters has been for ages mantling the ocean's floor. Here and there a giant peak rising from these sunless depths lifts his head to see the sky, and the dredge and trawl tell us that all along his rugged sides, and on the hills and plains below, and even in the inky blackness and the freezing cold of the deepest valleys, there is life.

The origin of life, said Dr. J. S. Burdon-Sanderson in his presidential address before the British Association, "the first transition from non-living to living, is a riddle which lies outside of our scope. No seriously minded person, however, doubts that organized Nature, as it now presents itself to us, has become what it is by a process of gradual perfecting or advancement, brought about by the elimination of those organisms which failed to obey the fundamental principle of adaptation. . . . Each step, therefore, in this evolution is a reaction to external influences, the motive of which is essentially the same as that by which from moment to moment the organism governs itself. And the whole process is a necessary outcome of the fact that those organisms are most prosperous which look best after their own welfare."

EMOTIONS AND INFECTION.

By M. CH. FÉRÉ.*

THE relation that exists between the activity of the nervous system and resistance to causes of destruction may be illustrated by facts of different sorts. It has been often remarked, and the registers of the academies confirm it, that we find many old men among scientific and literary people. Whether the resistance in question is attributable to the habitual exercise of the mental functions, or vital resistance and mental power are conjointly attributable to a good natural organization, the relation is no less certain. The same relation is found, susceptible of like interpretations, among persons without cultivation, whose existence has been, as we might say, all organic, and who are more exposed to the action of atmospheric inclemencies and to all the chances of mortality. The remark is attributed to Baillon by Cabanis that porters and laboring men offer only a feeble resistance to blood-letting and purgatives. Nothing is more remarkable than the facility with which weak-minded persons succumb to acute diseases of every kind.

Many violent maladies have been supposed to have been produced under the operation of moral influences. Sennert believed that fear was capable of provoking erysipelas. Hoffmann also made fear and the adynamy resulting from it play an important part as the predisposing cause of contagious diseases. Dr. H. Tuke believed, in particular, in the influence of fear upon the contagion of rabies. The breaking out of rabies has been sometimes observed after psychic emotion. Bouley cites the case of a dog which went mad after having been immersed in water. Gamléia cites a similar case in a man, and another in a woman who was frightened by a drunken man. In order to avoid the influence of fear, Desgenettes concealed the name and the nature of the plague; and it is to be remarked further that the Turks died less rapidly of it than the Christians. Cullen supposed that sad emotions favor contagious diseases, and particularly the plague. This disposition to contagion after violent emotions which determine discharge of the secretions may be partly explained by the fact that the conditions that diminish the proportion of the liquids of the blood favor absorption. It, however, seems at least probable that the nervous discharge is accompanied by alterations of the blood and modifications of the interior medium which justify the popular expressions concerning having bad blood and turning the blood. It is admitted that

* From his work on the Pathology of the Emotions. Paris: Félix Alcan.

violent emotion is capable of causing and of curing intermittent fever. In the latter part of June, 1889, M. Jullien, a surgeon of Saint-Lazare, called me in consultation over a neurasthenic and hypochondriac patient who thought he was suffering from ataxy. He was a vigorous man, without any stigmatic marks of degeneresence, but very emotional. He had had some attacks of marsh fever in Poland about twelve years before, but had not suffered from it since. At St. Petersburg, when near the place where Czar Alexander II tragically perished, he experienced a violent emotion, after which he suffered for three days attacks of well-characterized fever. A new attack came on at Paris a few months before my visit, corresponding with the emotion he experienced on finding a friend dead in the Hôpital Beaujon.

The old authors give the moral emotions a part in most eruptive fevers. We meet them in the etiology of cholera. Pneumonia sometimes appears on the occasion of a strong moral emotion. Rostan relates the story of a woman who was suddenly struck with a very severe pneumonia on receiving news of the death of her son. Grisalle observed it in a woman who, learning that she had been robbed, experienced instantly a violent attack, which was followed promptly by a chill, a stitch in the side, and spitting of blood.

Depressing emotions often seem to have an action on the development of tuberculosis. Laënnec believed that griefs and annoyances were important constituents in the frequency of phthisis in large cities.

Puerperal infection is also favored by depressing moral emotions. "I have often in my practice," says M. Hervieux, "seen young women in childbed, in a fair way toward recovery, take a chill and become mortally ill after a visit or untimely reproaches from their mother or relatives; or after the agitation or perplexity occasioned by their resolving to abandon their child, unfortunate girls, till then doing well, falling ill on carrying out the resolution and succumbing in a short time." Rivière, Willis, Denman, Delaroche, Paul Dubois, Alexis Moreau, Tonnelé, and others attribute an important part in the etiology of diseases of women in childbed to the moral affections; and this opinion is supported by more recent observations.

The emotions, likewise, have a part in the evolution of surgical diseases, and particularly in their infectious complications. The theories recently put forth to explain contagion and immunity from infectious diseases may agree with the facts we have learned relative to the influence of the emotions. Among these theories is one to which the facts lend an important support. In this theory the mesodermic cells, and particularly the white globules, are charged with the protection of the organism against the in-

vasion of microbes. We know that the leucocytes have the property of moving and putting out prolongations, by means of which they surround foreign bodies and force them into the mass of their protoplasm. They behave in a similar way toward microbes, which, once surrounded, are destroyed by a real intracellular digestion, and we give the name of *phagocytism* to the whole of these operations. Now, dilatation of the peripheric vessels occurs in sthenic emotions, in which it is manifested by ruddiness, increase of volume, and functional exaltation. In asthenic emotions, on the contrary, inverse phenomena betray a diminution of circulation and a decrease in the caliber of the vessels, and consequently a condition unfavorable to the sally of the white globules and to phagoyctism. Asthenic emotions, from this point of view, lead to the same conditions as traumatisms, fatigue (Charrin and Bogen), chill (Pasteur, Wagner, Platania, Charrin), inanition (Canalis and Morpurgo), loss of blood (Serafini), and nervous sections (Charrin and Ruffer, Roger and Herman).

Not only do the conditions of the vessels change, but the phagocytes and the white globules especially are modified as to their vitality and their chimiotaxy, and their property of being attracted or repelled by the microbes or their products of secretion vary under the same circumstances. Under the influence of cold the white globules tend to become paralyzed. MM. Massert and Bordet, whose experiments seem to demonstrate the absence of a relation between the chimiotaxic action of the leucocytes and the condition of the vessels, admit that under defective conditions of nutrition the whole organism is more easily impregnated by a poison which provokes at every point the chimiotactic activity of the leucocytes, which then have no occasion to direct themselves toward any particular point. The modifications in the composition of the blood after nervous excitements and under emotions which we have mentioned can also be adapted to this theory. Experimental data show that in all conditions in which nutrition is deficient—and painful emotion is one of these conditions—infection is caught more easily. Evidence of this is not only derived from animals; I have had occasion to observe on man several facts which give support to results obtained in the laboratory.

Having to revaccinate patients in my practice, I inoculated a dozen hemiplegic persons symmetrically in both arms in order to see whether the paralyzed side would offer a different resistance to the virus. Real vaccine was not developed in any of these patients, all of them having been vaccinated not more than three or four years before. Upon three of them only were developed pustules of false vaccine, exclusively on the hemiplegic side of one, and with a marked predominence of volume and duration on the other two.

In the case of a little girl eighteen months old, afflicted with infantile spinal paralysis of the left leg, with considerable chill, I made four punctures on the outer side of each arm with a lancet carefully charged with vaccine matter; the inoculation was successful only on the diseased side. Some more recent experiments bear in the same direction. On the other hand, certain medicines quieting to the nervous system, like opium, morphine, chloral, and bromide of potassium, seem also to favor infection.

The influence of the emotions on infection is further susceptible of a direct experimental demonstration. Having under my care a number of weak-minded persons susceptible of taking interest in a monotonous exercise, I profited by the opportunity to try upon a considerable number of animals—pigeons, rabbits, and white mice—the effect of fear, which was excited by means of noise or threatening motions, through several consecutive hours. The experiments may be divided into three groups: 1. The blood of frightened animals and of witnessing animals was sown. While the blood of the latter animals was sterile, that of the former gave in half the cases more or less numerous colonies of microbes. 2. Animals, some of which had been left at rest, and others had been disturbed, were inoculated with cultivations of pathogenic microbes—of carbuncle, hen cholera, pneumo-enteritis of swine, and Fraenkel's pneumococcus. In all the experiments, without exception, the frightened animals died first, if the cultivations were virulent; while if the cultivations were attenuated they alone died or were ill. We have seen animals little susceptible to an infection succumb to it under the influence of fear; frightened pigeons yielded to pneumo-enteritis of swine, while mere witnesses did not appear to be affected at all. 3. On introducing under the skin of the ear or of the brow of rabbits, or under the skin of the wing of pigeons, capillary tubes closed at the end and filled with cultivations of pathogenic microbes or of saprophytes, we discovered considerable differences in the chimiotactic properties of the white globules, according to the condition of the animals. With frightened animals the tubes were often found at the end of thirty-four hours entirely filled with transparent liquid, while with witness animals the tubes containing whitish trails through their whole length were choked at the ends with a compact wad of leucocytes two or three millimetres long. Most of the microbes had disappeared in the case of healthy animals, while a very large number of them remained in the fluid of the other animals, in which the microscope could discover only a very few leucocytes. We are therefore able to show experimentally in frightened animals that one of the conditions of resistance to infection is absent. The study of these facts deserves to be pursued in detail.

We know the influence local traumatisms have on the location

of the accidents of infection and of diseases of nutrition. Moral shock is in reality equivalent to a cerebral commotion; and, without forcing analogies too far, we are able to understand that it all the more readily can provoke cerebral lesions.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

UNCLE SAM'S LIFE SAVERS.

By FRANK G. CARPENTER.

THE United States Life-saving Service is now one of the great institutions of our Government. Its system embraces the dangerous parts of our Great Lakes and oceans, and its hundreds of stations cover a coast line of more than ten thousand miles in length. It began to be as far back as 1848, but in its present organization its life commenced in 1871, when Congress made an appropriation of $200,000 and established some experimental stations along the New Jersey coast. These at once showed the value of the system, and to-day on the Atlantic and Gulf of Mexico there are one hundred and eighty-two different stations, while there are about fifty on the chain of the Great Lakes, and a steadily increasing number on the Pacific.

The buildings are located sufficiently far from the water line to be safe from high tides. They are plain structures, designed to serve as barracks for the crews and to afford convenient storage for boats and apparatus. Each station is generally equipped with two surfboats and their accessories, two sets of "breeches-buoy" apparatus, life lines, life car, a vehicle for the transportation of boats to points where needed, a Lyle gun, cork jackets, signal lights, rockets and flags, well-equipped medicine chest, instruments of various kinds, together with everything necessary for the comfort and well-being of the crews. Where practicable along the Atlantic coast, the stations are connected by telephone. At a few points there are long stretches of uninhabitable coast, and houses of refuge have been established at intervals of about twenty miles for the shelter of shipwrecked persons. They are supplied with cots and provisions for twenty-five persons for ten days. On the Ohio River, at Louisville, there is a floating station. The great rise and fall of the river renders impracticable the use of a stationary building. In recent floods the crew of this station were of incalculable service to the people of Louisville. Hundreds of imperiled persons were rescued, and thousands who for days could not leave their houses were supplied with food and other necessaries.

Each station and its crew are in charge of a "keeper," who

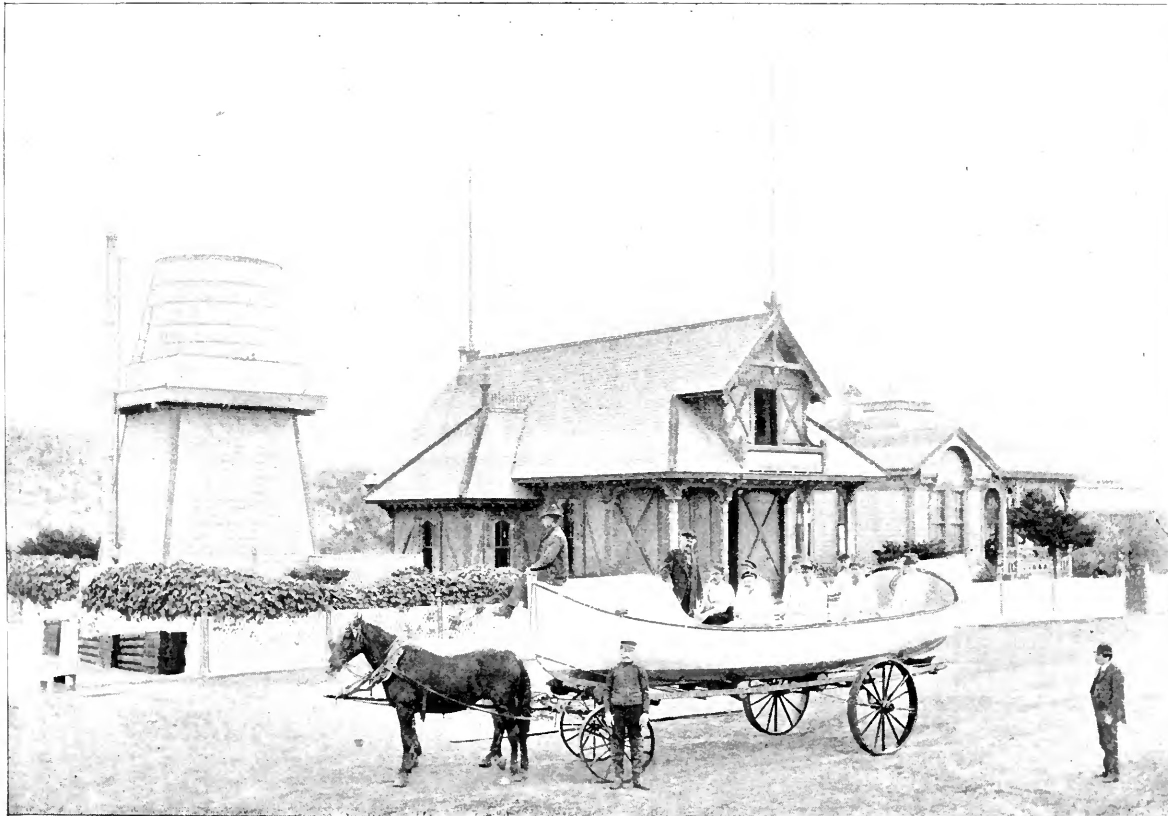

Fig. 1.—Ready to Start.

must be of good character and habits, sound, able-bodied, and a master of boatcraft and "surfing." He must live at the station, exercise absolute control over the crew, and direct all operations. In times of danger he must lead where duty calls, sharing with the men all the perils of wind and wave. The crew usually numbers six or seven, who are selected with especial reference to their fitness for the service required of them. It is indispensable that they be experienced surfmen and skilled in the handling of boats. It may be here remarked that political considerations have not the slightest influence in the life-saving service from its chief down. If politics were permitted to dictate appointments, a serious impairment of the service would speedily result.

A surfman is paid sixty-five dollars per month, with no allowances except quarters at the station. He provides his own food and clothing. No man or officer is permitted to have an interest in any wrecking apparatus, or to be connected with any wrecking company; nor is he entitled to salvage upon any property saved. If disabled in the line of duty, a member of the crew receives full pay during such disability, not exceeding one year. If he loses his life—and this is not infrequent—his widow or children under the age of sixteen are entitled to his pay for two years.

When the season of active duty begins, the men establish themselves at the station for a residence of eight months, embracing on the sea-coast the autumn, winter, and spring seasons. On the Great Lakes their active service is from the opening to the close of navigation. For domestic convenience they resolve themselves into a committee of the whole which they term a "mess." They take weekly turns in catering and cooking. The keeper organizes his crew for the season, designating them as Number 1, Number 2, etc., in the order of merit and efficiency. Each man holds rank according to his number. Watches are kept by day and patrols by night. If two stations are within communicating distance, the patrols meet midway each time they traverse their beats. Every patrolman is equipped with signal lights with which to warn vessels or to give an alarm in case a vessel in distress is discovered.

The members of the crew are drilled daily in the handling of boats and life-saving appliances. By practice they acquire agility and expertness that are almost incredible. The highest possible efficiency in times of actual service is thus secured. The men are also instructed and practiced in applying the most approved methods for the restoration of persons apparently drowned. In some cases this is accomplished after twenty or thirty minutes of unconsciousness. It will be readily understood that these men must possess great courage and powers of endurance. Their service is full of danger and often their lives are in extreme

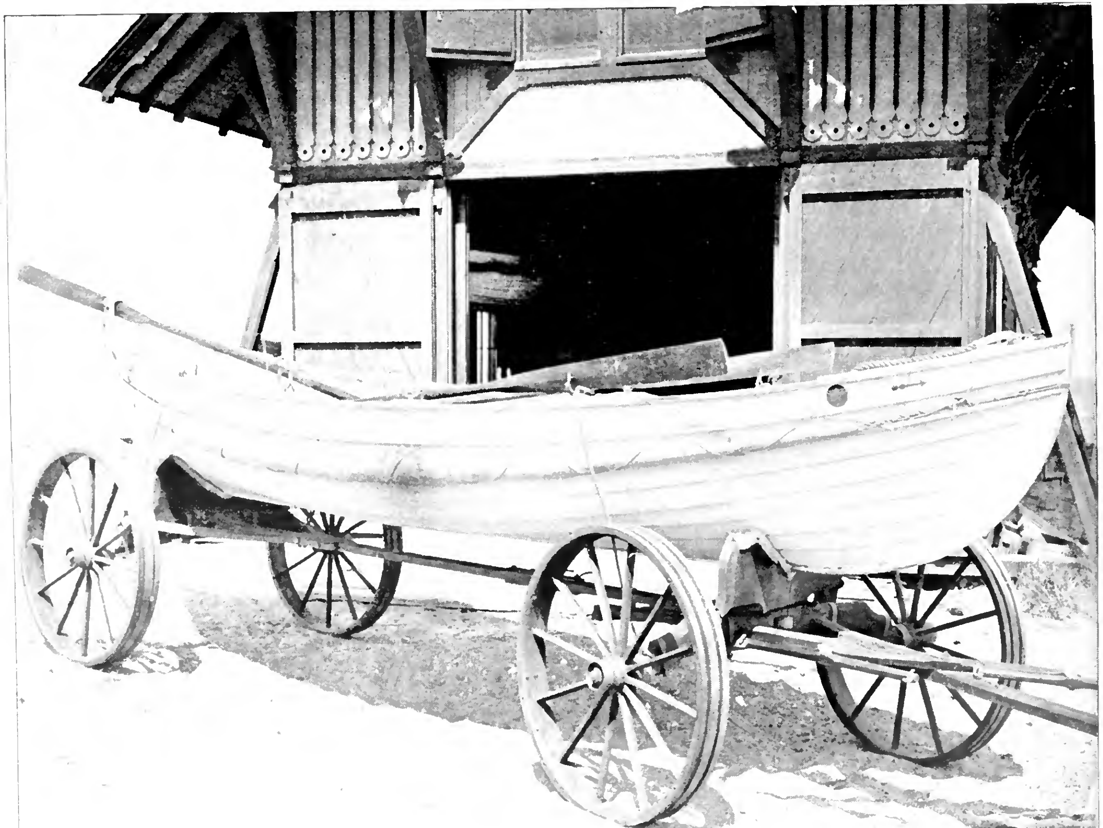

Fig. 2.—Surfboat.

jeopardy. Their devotion to duty and humanity are beyond praise.

For convenience of supervision the stations are grouped into districts, of which there are twelve. Each is in charge of a superintendent, who must, at least once a quarter, visit the stations in his district, and who is held responsible for their condition in all respects.

The means employed to rescue people from stranded vessels are everywhere essentially the same. The tumultuous waters be-

Fig. 3.—Bringing Crew Ashore in Breeches Buoy.

tween the wreck and the shore are either crossed by a lifeboat or are spanned by strong lines over which a car or breeches buoy is passed to and from a wreck. There are many kinds of lifeboats and many other devices for effecting communication by lines between a wreck and the shore. The type of boat in most general use in our service is distinctively known as a surfboat. It is made of white cedar upon a white-oak frame. It is from twenty-five to twenty-seven feet in length, with its other dimensions proportionate. It is propelled by six oars, and will carry, besides the

crew, from ten to fifteen persons. The excellence of these boats is shown by the record during the eighteen years they have been used in the hands of the life-saving crews. They have been launched in actual service six thousand seven hundred and thirty times, and have safely landed from wrecked vessels six thousand seven hundred and thirty-five persons. They have capsized but fourteen times, six of these accidents being attended with loss of life. Of the boats' crews, twenty-seven were drowned, being one for every two hundred and forty lives saved.

A "self-righting" lifeboat is largely used in the English service, and in our own to a limited extent by way of experiment. This boat is constructed with air-chambers at the bow and stern and several hundred pounds of iron in the keel. These cause the boat to "right" itself when capsized by the waves. It is of necessity heavy and cumbersome, and the record for actual service is on the whole favorable to the smaller and lighter surfboats adopted by our own Government. The proportionate loss of life from capsizing is considerably less with the surfboats. The self-righting boat is fourfold heavier than the other, weighing about four thousand pounds. Boats are being constantly improved and perfected, one of the latest devices being for self-bailing, by which water that may be "shipped," or fills the boat as the result of a capsize, is instantly expelled. A boat combining successfully the properties of self-righting and self-bailing would seem to be the nearest possible approach to the ideal.

The "Lyle gun" is the means adopted for effecting line communication with stranded vessels. It is of bronze, and of 2½-inch bore. It weighs with its carriage but a hundred and eighty-five pounds, and throws a shot weighing seventeen pounds. This projectile is a solid cylinder fourteen inches and a half in length, into the base of which is fixed an eyebolt for attaching the shot-line. The latter is from an eighth to a quarter of an inch in diameter, and pays out from a coil as the projectile flies upon its way. The aim is to carry the projectile directly over the vessel in distress. The line falling upon the deck is seized by the sailors, and by it a large line is hauled from the shore and made fast, affording means for the immediate use of the life-saving appliances. The Lyle gun will project a line, under favorable conditions, a distance of seven hundred yards. It is easily operated by day or night. During a storm at night great skillfulness of aim is necessary, as there is no guide save the dim light upon the swaying vessel. When the distance is not too great, the practiced eye rarely fails.

The vehicle in most common use, in this and other countries, for transporting persons to the shore, is the "breeches buoy." It is a primitive, simple, and yet most effectual means of saving life.

It will carry but one person at a time, but it is easily and rapidly handled, and this fact renders it invaluable. It is made of stout canvas, something like a pair of breeches for the legs, from which it takes its name. From a circular float which comes just under the armpits ropes are attached, which suspend the buoy from a pulley block running upon the large line. It takes but a minute for a man to fix himself in the "breeches," and then he is hauled through the air—perhaps part of the way through the water—to the shore. Whenever practicable, the line at the vessel is fastened

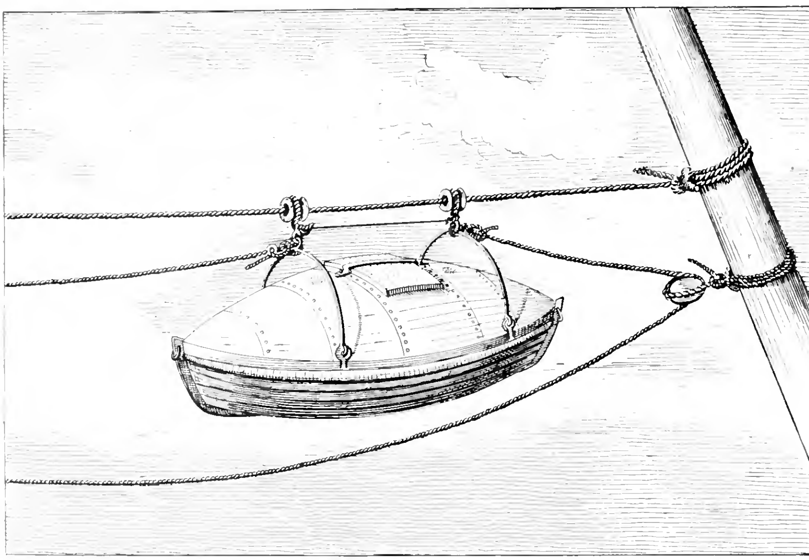

Fig. 4.—Life Car. United States Life-saving Service.

tight upon a mast, so that the passage may be made without immersion. Many thousands of lives in all parts of the world have been saved by this simple but effective device.

The "life car" is brought into requisition when the number of persons to be saved is large and circumstances require that the work be done quickly, as when a vessel shows signs of breaking up. It is a covered boat, perfectly tight with the exception of a few small holes for the admission of the air. It may be hauled upon the water by means of lines, or suspended from the hawser and passed to and from the wreck. It will contain six or seven persons, and is a comparatively safe and speedy means of rescue. The life car was designed by Joseph Francis, who but a short time ago received, at the hands of the President, a superb gold medal, voted by Congress in recognition of its value. Upon the first occasion of its use more than two hundred persons were safely landed from a wreck.

The value of the telephone as a means of communication between contiguous stations was lately illustrated. During one of the worst and most destructive storms that ever visited the Atlantic coast a large number of vessels were driven ashore at and near Cape Henlopen. The crews of three life-saving stations were summoned, and their combined labor effected the rescue of a hundred and ninety-four persons from twenty-two vessels. Of these, a hundred and thirty-five were landed with the "breeches buoy." Not one life was lost during the operations. Crews, with their boats and apparatus, are often transported long distances by rail to meet emergencies. On the shore of Lake Superior such a trip was once made a distance of a hundred and ten miles, the railway train running at the utmost possible speed. The spot was reached at midnight, and in the midst of a blinding snowstorm thirty-four persons were brought safely to shore from two stranded vessels.

At the stations shipwrecked persons are cared for with dry clothing, nourishment, and medicines. Often they are exhausted by exposure or hunger, or injured by the accidents of wreck and rescue. Frequently they are to all appearances dead. The record shows that during the existence of the life-saving service there have been treated a hundred and eighteen cases of apparent death. In sixty of these resuscitation was successful, failing in fifty-eight. In a few instances respiration was restored after several hours had elapsed. While the saving of life is the primary object of the service, it has a secondary duty in the saving of property, which runs up into the millions.

Before the service was established no statistics of loss of life were recorded, so that it is not possible to show by comparison the decrease of deaths by shipwreck as the result of the efforts of the life-savers. It is learned from authentic information, however, that upon the Long Island and New Jersey coasts, during the twenty years from 1850 to 1870, the average annual loss of life was twenty-five; while during eighteen years of the service the yearly average has been but seven. No doubt a similar ratio would apply to other points of danger along our coasts. Each successive year shows a better record, as life-saving appliances are more nearly perfected, abundantly attesting the efficiency and value of this branch of Government effort in behalf of its people.

In the opinion of Mr. Henry Seebohm, the extreme views of the theory of an ice age have been to a large extent abandoned. No one now believes in the former existence of a polar ice cap, and possibly when the irresistible force of ice-dammed rivers has been fully realized, the estimated area of glaciation may be considerably reduced. The so-called great ice age may have been a great snow age, with local centers of glaciation on the higher grounds.

WINDOW LIGHTS AND THEIR VALUE.

By JAMES L. GREENLEAF,
ADJUNCT PROFESSOR OF CIVIL ENGINEERING IN COLUMBIA COLLEGE.

MOST subjects of analysis can be studied both in quantity and quality, and light is no exception to the rule. Color as a quality of light has always been a popular study. A vast deal of experiment and attention has been given to the harmonics of color, and many who make no claim to scientific attainment are well versed in it. Every child knows the colors, but the expression "quantity of daylight" has a strangeness and a vagueness about it that are not felt by children only. This is largely because there is such a wealth of daylight about us. "Silver was nothing accounted of in the days of Solomon." Light is not measured, because it is lavished upon us by an unstinting hand. But light can be measured. Although intangible, it has quantity—quantity of effect, if it may be so expressed. If this seems fanciful, it may be remarked that there is nothing fanciful about the measurement of heat, and yet the case is quite analogous. The thermometer is simply a contrivance for measuring variation of intensity in heat. Quantities of heat effect are continually being estimated, for economy in its use is of prime importance. Light, on the contrary, is ready at hand. Ordinarily objects are flooded with a brilliancy of daylight which is as free as air. There can scarcely be need of economy with light when the world is floating in it. But there is nothing impossible in its measurement. Possibly, if the sun were less prodigal in pouring out his rays upon the earth the measurement of daylight would be a more common operation than at present. Every means would be taken to utilize it without waste. We would see the owners of buildings making careful estimates of the light belonging to their properties—even dividing it into lots and renting them separately. At the least, we would see them more jealously than now defending their light from obstructions built around them.

Windows are the natural and all-important resource of the architect. All the light which enters the building must pass through them. It is a very patent fact that the larger they are, and the more numerous, the greater the total amount of light which enters. It is not as widely appreciated, however, that there are other conditions affecting the amount and quality of the entering light that are sometimes ruling in their effect.

Looking from a window, one sees a variety of surfaces—sees them because of their reflecting different intensities and colors of light. If asked to classify them according to relative reflecting

power, he will probably speak of the sky first as the great source of light to the window. Then, if he does not ignore them altogether, the objects on the earth are grouped in one class of comparatively little importance. This is not Nature's method. There is no sharp division between the strong reflecting surfaces and the weak, between the sky and the earth. We are prone to such a distinction, because the sky seems prominent as a reflecting surface, but it can be shown that circumstances arise when this is by no means true.

Imagine the window to look out upon a landscape. Earth, foliage, and sky all combine to reflect light into the room. The water may be very dark, from the shadow of overhanging trees, reflecting less than ten per cent as much light as comes from the sky, but there is a path across it where the sunlight is cast back far more brilliant than the sky itself. The beaten highway gleams in the sun so that it is a relief to look away from it into the blue above. Even the foliage, delightfully dark and cool in the shadows, may have a brightness where the sunlight strikes it which is fifty or eighty per cent of the intensity of sky light.

On turning from the country to the city view we find the lessened importance of the sky as a source of light especially emphasized. There the great value of space causes one building to encroach upon the sky light of another until frequently the patch of blue visible from the windows is limited to a mere streak, or may be cut off entirely. If the sky were the only means of lighting, the windows would be useless in such cases; but the fronts of buildings, the paved streets, and other surfaces combine to throw much light into them, and give a reason for their existence.

The reflecting power of the sky dome is due almost entirely to the particles of vapor contained in the atmosphere, and hence must be considerably affected by changes in its aqueous condition. Contrary to what might be imagined, the clearer the sky the less valuable is it as a reflector. The more haze that it contains within limits the more intense the light obtained from it. An observer will recall dreamy summer days when the sun has seemed to shine softly as through a gauze cast over its face and the shadows were mellowed and diffused, yet the sky was white with a radiance painful to the eye. There was little suggestion of ethereal blue in the white light sent down from this atmosphere charged with particles of moisture. Again, a clear day comes; the air fairly dances with brilliancy, and distant objects stand out in the sunlight as clear-cut as a silhouette. The sky is a beautiful Italian blue, but does it occur to one how really dark it is except in the immediate vicinity of the sun? Try to match it with a sheet of blue paper, and it is almost startling to discover what a somber surface the sky dome is. Its value as a source of light is greatly

less than on days when it is a duller blue, or when gray better describes its color. Some experiments which are at hand show a difference of over seventy per cent in the reflecting power of the northwest sky on two sunshiny days, and they were by no means extremes of the two conditions of atmosphere discussed. No experiments upon extreme states of the atmosphere are available, but it is safe to say that the reflecting power of the sky dome in this climate is one and a half times greater on some days than on others. Between the extremes are all possible variations.

Thus far the thought has been only of an unbroken expanse of sky, but if clouds float across the field they greatly change the conditions. A cumulus cloud piled high in great masses is carried past the window by the wind. It gleams beneath the sun's rays like a ball of cotton, and pours down a flood of light that may have as much as four times the intensity of the light from the sky directly beside it. At another time heavy thunder clouds will roll up from the horizon—a dark gray, unillumined by the sun. They obscure the sky and replace it by possibly ten per cent of its intensity of light.

Indeed, does it not seem as if there were no stability about the sky light? And yet, brushing the clouds aside, it will be found that the changes in any one day are not usually great. There is enough permanency in its reflecting power to make it serve as a practical standard of comparison—a standard not for the direct sunlight, which so far transcends any other light on the earth as to be unique, but for the vast variety of lights which crowd into the windows—the reflections from brick and stone, from wood and paint, from earth, water, and foliage.

Turning from the sky to the earth, a vast variety of reflecting surfaces is encountered. Each has its peculiar power of altering the light it reflects, both in intensity and quality. The amount of their influence upon window light is apt to be underestimated. Many rooms through the entire day and nearly all rooms for a portion of it have no direct sunlight, and all the light they do receive is entirely by reflection. Of this the portion coming from surfaces on the earth is a very considerable part.*

It is true that most surfaces reflect but a small percentage of the light which strikes them, but when that light is the great flood from the sun itself the pittance which comes from them is

* In a number of cases carefully determined in city locations it has been found that the sky gave only from eight to forty per cent of the total light reaching a point inside a window on the ground floor. The remainder came from opposite building surfaces and from the street—this, with the sun shining upon these reflecting surfaces. At another time of day the sky value would be comparatively greater, yet not so much as might be imagined, because all the surfaces would not lie in shadow at the same time.

by no means contemptible. An illustration of this may be given. While reading on the shady side of a railway car one afternoon, a sudden flush of warm-tinted light seemed to cover the page and as quickly it was replaced by a cold gray light. The change was very noticeable and the cause easily revealed. At intervals along the track were stretches of rough-faced masonry, perhaps seven feet high. The stones looked in shadow a dull gray and a buff color, but when the sun struck them they glowed with a light that flashed into the car window. In spite of the fact that the area of sky light was far the greater of the two, that rough retaining wall determined in a great measure the character and intensity of the illumination on the paper.

Light-colored surfaces are the most valuable reflectors, and among them white paint and whitewash stand pre-eminent.* Even in shade, when illuminated only by other objects or by the sky, they will give sixty per cent or more of an average sky light. Sometimes they will run up to the full value of sky light, if a reflecting surface near by shines brightly upon them, or they may fall to twenty per cent or even less in deep shadow. But when the direct rays of the sun fall upon a newly whitewashed surface, the volume of light it reflects is almost blinding. Three hundred to four hundred per cent is not too large an estimate to place upon it in comparison with the sky light. On this account the well-known expedient is used of whitewashing or painting in some bright tint the walls of a light-shaft or surfaces facing a window which is much shut in. A case is known of the rear of a house so treated being in summer time a source of great annoyance to dwellers on the next street, because of the blaze of light reflected into their rear windows. White marble is quite similar in its powers of reflection. A striking example can be seen in the spires of St. Patrick's Cathedral in New York. Rising far above the dust of the city, they are not yet covered with its grime, and their pure white glistens in beautiful contrast to the dark blue of the sky.

From the white of paint or marble there are many variations in building surfaces, all the way down to black. A large number are to be found among the granites. Some varieties are very dark in tone, reflecting little light unless polished, but the gray granites give considerable light. A freshly tooled gray granite will certainly yield one hundred per cent of sky light when in sunshine, and some varieties give far more. The writer has known the gray granite of an old building to give one hundred and forty

* The percentages stated in the following pages are based upon a large number of photometric measurements of the light from building surfaces, made by the writer at various times and places.

per cent, as compared with the sky light of a clear day. When it was in shadow the intensity fell to only ten per cent.

The brownstone, so familiar in building construction, is justly looked upon as a gloomy material for the purpose. Connecticut stone is the darkest, and, especially when oiled, is a somber thing with which to enliven architecture. But even when oiled it does not absorb quite all the light which strikes it. The searching light of the sun will find many little particles among the grains of the exterior that give surface reflection, and this white light mingles with the dark interior hue of the stone to brighten it considerably. The Connecticut stone under ordinary conditions gives some sixty to seventy per cent of the intensity of sky light, when the sun shines brightly upon it. Belleville stone is much lighter, and has been shown to exceed the sky light by twenty or thirty per cent when illuminated by the sun.

Among the bricks there is a large opportunity for choice in their capacity for reflecting light. The Philadelphia pressed brick is popular for its richness of color, but deserves no prominence for its reflecting power. In that respect the coarser Hudson River brick is an improvement. There is, of course, considerable variety, but it may in general be said that walls of Philadelphia brick, and those painted red to imitate that shade, will reflect sunlight to an extent varying between fifty and eighty per cent of ordinary sky light. When illumined by only indirect light from the sky or other sources they have an intensity of fifteen to twenty per cent of the same sky light. With rough brick walls there is always a considerable show of light-colored mortar, and this, with the lighter surface of the bricks themselves, causes a greater reflecting power. It is easy to find surfaces of this character with a reflecting power when illuminated of ninety to one hundred per cent.

Buff-colored bricks make admirable reflecting surfaces. With the sun upon such a surface it will often reflect one hundred and sixty per cent or more of sky-light intensity. Many opportunities will offer in modern construction for the observer to bring such an illuminated surface against a sky background, and see how much brighter it will ordinarily be. Its practical value as a reflector is greatly lowered in his estimation, however, when he finds that, if the sun is not shining upon it, twenty-five per cent is a liberal estimate of its powers of reflection.

The climax of reflecting power in brickwork is reached in the cream and white enamel brick that are in the market. They are chiefly used for interior work, and their polished surfaces place them in a different class of reflectors from the ordinary building materials.

Slate roofs belong to the same class in a certain degree. The

ordinary slate when held in the hand appears a very dark blue; little light is reflected from the interior, and that little is mainly blue, while the very small amount of white light reflected from the surface is not enough to pale the interior hue to any great extent. But turn the slate so as to reflect the light differently, and then there is such an excess of surface reflection as to give even a silvery tone to what was a moment before a dark material. A twist of the wrist will easily make a difference of two hundred per cent in the reflecting power. The extremes and all the intermediate conditions can be seen in slate roofs, and these are in a position where comparison is easily made with the sky. One roof will look almost black, as it stands out against the sky; another that reflects the sunlight will gleam like a white sail on the horizon. At another time it may melt away with a hue and shade that are not to be distinguished from those of the blue sky back of it. The same effect is obtained with shingles, but in a less degree.

The pavement of city streets affords some interesting observations. It is ordinarily looked upon as only fit to be trodden under foot of man, and very little credit is given its reflecting power. Paving stones appear of a rather somber color when held in the hand, and ordinary blue flagstone is similar. Hence it is surprising to learn that dry flagging, when illuminated by sunlight, is about the equal of the highly prized sky as a reflector of light. A considerable number of experiments, taken at various times and places, go to show this. Under ordinary conditions of dirt the pavement may be slightly darker than the bluestone flagging, but they will both give approximately one hundred per cent of sky light. Moreover, their hue is not unlike that of many skies. The idea is perhaps difficult to grasp, in view of their condition; but if a section of New York street could be purified and translated, it would quickly be lost to sight, ascending in a sky of its own color. When in shadow, fifteen to twenty per cent represents the amount of light that the street will give as compared with the sky. If the stones are wet, not more than ten per cent of light comes from them, except where there may be a powerful reflection of white light from the water upon the surface.

It has perhaps been noticed that thus far, in discussing reflecting surfaces, attention has been confined to the changes they produced in the intensity of light. These are not, however, the only alterations that occur. Quality as well as intensity is affected by the surfaces which throw light into the window. Leaving now the intensity of reflecting power, let us endeavor to realize what is taking place in every city street. It may be a thoroughfare filled with the noise of travel, but the air is crowded with silent lines of light. Back and forth they fly in all directions, every

surface receiving light, every little grain and fiber acting as a reflector to send it out again. Reflection and re-reflection are taking place with enormous rush and intricacy. But the extent of complication is not yet reached. These various lights are not all white. Each substance has its effect upon the light that it reflects. Some of the light undulations are absorbed, and those reflected give the effect of color characteristics of the object. The colored lights are then flashing back and forth, continually changing as they leave the different surfaces. Neither is this a complete statement of the situation. Each surface is illuminated by a variety of colored lights, depending upon the surfaces opposite it. The color of any one material depends upon the color of the light striking it, as well as upon its own nature. Hence possibly none of the surfaces in the street are seen in their true tones, the hues belonging to them when illuminated by pure white sunlight. They are slightly off color, modified by the colored lights that strike them. All this wonderful play of lights darting across the street is put in action by the steady, powerful, pure white flood of light coming from the sun.

It may be questioned why this condition of affairs is not more noticeable. Why are not the bright hues of the rainbow seen in all directions? The absence of brilliant coloring is briefly accounted for by the large amount of surface reflection taking place, through which we see objects as if a gray glazing had been washed over them.

However, conditions will occur when there is a very noticeable flush of color cast over objects which is not their normal hue, and it can be traced to the predominating influence of some one of the reflecting surfaces. Occasionally most striking effects of this character are seen during the sunset hour. Sun-illumined clouds are in the west holding their bright color when all other sources of light in sky and earth are waning. The predominating power of their colored light is enough to make a modest little sunset in the east, and the sky there will glow with a soft tint sympathetic with the display in the opposite part of the heavens. The western sky may even give a glamour of colored light to the landscape, casting a weird, strange effect over meadow and hillside, ere they disappear in the darkness.

> "Where the quiet-colored end of evening smiles miles and miles on the solitary pastures. . . ."

Those who use colored parasols understand perfectly the result, if not the theory, when the lining of the parasol is selected so as to add to natural charms by casting a soft flush of color over the complexion.

But illustration of the influence of the effect of surfaces upon

the color of light can be found in more prosaic subjects. Buildings offer examples. Ordinary brick and stone often have more influence than is imagined upon the light that enters windows. A brilliant although exceptional example of this occurred once in the writer's office. It has an eastern exposure and nearly opposite, at a distance of over one hundred feet, is a large red-brick building. The sky area exceeds all others, and ordinarily the amount of gray or light-blue light entering is enough to entirely overcome the effect of the red surface. On this special occasion, however, after a rainy day the sun suddenly burst through the clouds. The face of the building was illuminated by clear white sunlight, and stood out brilliantly against a backing of heavy, dark clouds. The effect in the office was most noticeable. Where had been nothing but a cold gray light in an instant a glare of red was cast over everything. Table and book that had been dull looked warm in color, and the walls appeared, as if by magic, in the most delicate rose tint fit for a fairy's boudoir. True, these were conditions most admirably adapted to illustrate the point that surfaces opposite windows can affect the quality as well as the intensity of the light reflected, but others more common lead to the same conclusion.

An excellent opportunity for alternating contrast is offered by a ride on an elevated city railway. Let one select a time in the afternoon when the eastern sky is not so bright as to obliterate the effect, and seat himself on the right-hand side of a down-town train in New York city. If the buildings are not too far removed from the track, a very decided change is noticed as each block is passed. Where the opening of the street brings a considerable sky area into view an ordinary gray light is cast upon the newspaper. This is succeeded by a sudden flush of rose as a high block of red-brick buildings is passed, and again a street opening allows the western sky to assert itself. Moreover, let it be noted that this may occur not with a bright sunlight pouring upon the buildings, but when they are in shadow, except as the eastern sky illuminates them.

Occasionally the effect of surfaces opposite the windows upon the color of the light can be noticed inside of buildings, even with no exceptional atmospheric conditions existing. On any clear day, by limiting the rays striking a marble slab in a certain room chiefly to those from a brick building opposite, one can change the white marble to a deep rose tint of a most beautiful shade.

These various illustrations have many corroborations in experience. They show that the light entering windows must be considerably influenced in color by reflecting surfaces opposite, even though the effect be not noticeable. Usually this is not a

matter of any concern, because a slight difference in hue from their appearance under pure white light does not materially affect our appreciation of most objects. There are, however, special operations which are thus affected to an extent that is of practical importance. A conversation with a cotton broker, for example, will do much to increase respect for the sensitiveness of the trained eye, and convince one of the practical bearing of these matters. Careful observation is needed to judge cotton and grade different samples, and the eye becomes wonderfully skilled in doing so. A steady, clear sky light is desirable. Evidence is at hand of the injurious change upon the light caused by alterations in buildings across the street from a cotton sample room. In the course of building operations in Pearl Street, New York city, a dull, buff-colored wall was taken down and replaced by red brick. The result when the sun shone upon the surface was a noticeable and injurious change in the light that came into the windows. A flush of pink was cast over the cotton samples, perhaps too slight to be noticed ordinarily, and yet giving a tone to them which interfered with the judgment of their quality.

And now a few words in conclusion concerning the service the light performs when it finally reaches the room. That light which passes directly from the window to the eye is of no benefit, except as it enables one to see the outside view. Nearly all the light serves a far more useful purpose. It enters the window and sets in operation on a smaller scale the same phenomena that are taking place in the street. It is bandied back and forth between walls, carpet, furniture, and occupants. The light that these various surfaces reflect gives impressions of form and color by which we appreciate objects. By means of it we see our friends' faces, enjoy the pictures, read the book. It should be noted that light and color are entirely subjective. They are effects produced in the brain by different kinds of light undulations. We perceive the color of the upholstery and carpet because these have the faculty of sorting out undulations of special wave lengths and reflecting them. We perceive the outline of chair or of face partly by change of color, but chiefly by light and shade, the difference in intensity of the undulations coming from them and from objects behind them. To make the objects in the room distinct the light entering the windows must be conserved as much as possible. This will best be accomplished by banishing all dark materials. Heavy hangings absorb light as well as dirt. Oak or enameled furniture reflects the light that black walnut or rosewood absorbs, and a light-colored wall will do almost as much as a sunny disposition to fill a room with sunshine and good cheer.

SPEECH FOR DEAF CHILDREN.

By LILLIE EGINTON WARREN.

LESS than thirty years ago no attempts were made to give speech to the deaf children of this country. Signs, writing, and finger-spelling were the means of communication employed. It had been a gigantic task to arrange a system of education for a class of persons previously supposed incapable of advancement, and it is not surprising that articulation in its early days fought hard for recognition among the older teachers. Happily, the spirit of opposition is waning, and there is now a friendly admiration manifested by them for the best intelligible speech given to the deaf. They are right in demanding that it be intelligible. It is easy to accustom one's ears to the articulation of a person seen daily, and if the pupil conversed with none but his relatives and teachers there might be no complaint about peculiarities. Such is not the case, however. With rare exceptions the deaf child must struggle in the world just as his hearing brothers and sisters do. The speech that comes easily to them is acquired by him at the expense of time and effort; it is his due that it should be made intelligible and agreeable.

As is generally known, the various States have large institutions for the deaf and dumb, or, as sometimes called, deaf-mutes. Dumb and mute are terms no longer applicable to the deaf who receive the best instruction; for it is now conceded to be a mark of neglected education to be unable to speak to some extent. Formerly they were dumb because deaf; now those who are dumb are so because untaught. The first superintendents to give articulation any place in their institutions considered it an added touch to give occasional pleasure. They were too strongly attached to signs to believe instruction in the various school branches could be given by speech and reading from the mouth. A comparatively few scholars, chiefly those who once heard, were put in classes and received lessons in speech a half hour daily, or four times a week, perhaps less. During the other hours there was no practical use of what was gained. In all the branches of the course, the teacher, in many cases a sign-taught mute, conducted the recitations in signs, finger-spelling, and writing. Spoken words were not used more than is German or French by the average child who has a lesson in the language with many others a few times a week. Thus articulation failed to obtain a fair opportunity to show its merits. Gradually some of the various obstacles to its success have been removed, and its teachers are making persistent efforts to secure to every deaf child a chance to speak and to read the lips.

Upon the question how far school instruction can be imparted through these means without the aid of signs and finger-spelling opinions differ. In justice to many it must be remembered that they receive all classes of pupils; often they are bright and in good physical condition, but some are diseased, of ignorant parentage, and small ability. It may be the latter class remain in school but a short time. While there, thanks to the State's generosity, they need not be of any expense to their relatives; it often happens, however, that they can not be spared long from home duties. The principal must arrange to give them all the knowledge he can while they remain with him. No plan covering years will answer for them. Neither will a plan suitable for them be sufficient for those better situated and conditioned. Perhaps the teacher is himself deaf, the graduate of some State institution, a member of one or more organizations of deaf-mutes, associating daily with sign-taught adults. Without casting any disparagement upon his abilities, we beg leave to say he is not as competent to decide the matter as a hearing person would be; he receives opinions from both sides, but he can not judge impartially. The greater his faith in the character of those who advocate articulation, the greater his faith in that system, but being sign-taught himself, he would like to feel his education was superior. Some principals have an oral department, by which is meant that a certain number of pupils are taught speech, and by speech receive instruction in all studies. As much as possible they are kept apart from the other pupils. This is a decided improvement upon the first arrangement, though it is a matter for regret that some should have such an advantage over others. A few superintendents feel this, and are arranging to have all new pupils taught speech, and as the older ones are graduated the manual department becomes small. Other institutions advocate a combined method, using both speech and signs with all pupils, one or the other system receiving the greater attention according to the views of the principal in charge. Schools have been opened which give instruction to all pupils by speech only, and are called oral schools, and a number of teachers are scattered over the country who fill the positions of resident or visiting governesses. Thus there is a disposition to advance the cause of the education of the deaf, and a wide difference in opinion as to what is best.

The true test is in results. That system is excellent which enables the deaf pupil to take his rightful place in the world, attain business and social success, to be like unto others. Correct, fluent speech, with voice more or less agreeable, and the ability to understand others by watching the facial movements (whch is called lip-reading or speech-reading), may be acquired by the boy or girl suddenly deprived of hearing by illness or born deaf. To

secure these desirable gifts the pupil must be educated by a system which gives speech in the beginning and imparts all instruction through that medium. Prof. A. S. Hill, in calling attention to the poor showing in written language even among the college-bred, dwells upon the importance of practice sufficient to enable the pupil to write without thought of the mechanical difficulties, maintaining that to be the first essential in efforts to acquire a good style. "A boy must have written much before he can form his letters without special pains; and much more before he can set down what he has to say without stumbling over punctuation, spelling, and grammar; and more still before he can write with facility." Upon the same principle the deaf child must articulate words long before he can do so readily; must speak in sentences long before he can do so fluently; and must talk on every occasion, to his teacher, to his classmate, in his lessons and in his play, before he can do so easily to the stranger and in society. Practice is the only means of attaining a spontaneous use of the vocal organs. Nothing else will do away with a consciousness of the mechanical difficulties.

The hearing power of the young infant is an unknown quantity, because the sensitive bundle of tissues responds quickly to impressions from various sources and is thus misleading. A loud noise may startle by its strong vibrations against the skin fully as readily as by the auditory sense. Intelligent parents have failed to discover deafness until their children were over a year old. The look of the very young deaf child is usually an interested one, accompanied by fewer unnecessary movements of the eye and less play of the facial muscles. From increased observant faculty comes a marked development of the imitative functions. The child's hands spring to his help. He goes through motions that he has noticed those about him use; in their case, however, speech and lack of observation have kept them from consciousness of those movements. They begin to see his, they are unaware of theirs; to them the child has invented his own signs. This fact discovers another. It is impossible for the normal human being of tender age to imitate easily a position of the mouth unaccompanied by the sound belonging to it; thereby proving the ear guides him more than the eye, and it is the absence of the hearing sense that obliges the vision to act early in behalf of the deaf child. A boy of two years was told to imitate what he saw in another's face; the lips were pursed, but he failed to round his until the sound of *oo* was made, though his deaf brother, noticing his difficulty, brought a spool to him to show the shape. Through hereditary tendencies the connection between the ear and the speech center is short and practicable; through educative means that between the eye and the speech center may be complete and

effective. Hearing need not be lacking to secure this result, for one possessing an acute ear may read speech from the facial movements. It is doubtful if there are many of the teachers of articulation to the deaf, a work requiring sensitive hearing, who consciously or unconsciously do not put to practical use some of their knowledge of the appearance given to the features by speech. This ability of the eye to take upon itself duties heretofore supposed to belong to the ear exclusively is a priceless boon to the deaf. Let others be instructed according to Francis Gouin's axiom: "The organ of language—ask the little child—is not the eye; it is the ear." We may add, if the ear has lost its cunning, the eye is a wonderful substitute.

The signs used in educating the deaf were perfected by hearing men and are arbitrary, learned by teacher as well as pupil, and unintelligible to most persons. The first signs employed by the little child, being copied from those in daily use among all classes of people, are termed natural. They express the putting on and taking off of the hat and coat, and thus the going out and the return home; the opening and closing of books, boxes, and doors; the acts of eating and drinking, driving, whipping, pushing, pulling, beckoning, running, and jumping. Animals are watched. The shape of the cat and the dog's mouths while giving their peculiar cries, "meaw" and "bow-wow," is copied; the curious action of the rabbit's legs when the creature is lifted by the ears is noticed and imitated; the first and second fingers of both hands raised to the head show that the movements of a horse's ears are observed. Impressions being conveyed through the sense of touch, the child communicates with others by describing in gestures the shape of the object he has felt. His eye has seen the form of a ball; but he knows more about it than the eye can reveal, for he has put his hands around it. Touch, taste, and smell come to his aid. The lack of facial movement gives place to grimaces; the nose becomes an expressive feature, and bitter and sweet, like and dislike, are revealed by strong looks. Accompanying ignorance of sounds there is an unconscious play of the vocal organs, forming a series of more or less unpleasant grunts and screams. The child's mental food is in what he sees, pictures or "images." He makes good use of all, showing an excellent ability to reason, but is liable to mistakes incidental to the fact that he may not have had the truth presented to him. A piece of chalk has been broken. He puts the parts together, appealing in that way to have it mended. His faith is large and his knowledge small. Some one takes them from him, dexterously substitutes a fresh crayon, and gives it to the child. He is not to blame for thinking it is possible to put together the pieces so perfectly that no one can see the mark of break. At another time, the honest-

minded person who tries to show him that such injuries can not be repaired will be thought unkind and unwilling to join the parts.

In the opinion of many, deaf persons are high-tempered, unruly, obstinate, and vindictive. The untrained, uneducated deaf may become so, just as the untrained, uneducated child in full possession of hearing may grow into a dangerous brute. It is not the deafness that is responsible. Too much stress can not be laid upon the importance of inculcating prompt obedience. There is no reason why a deaf child should not respond quickly to another's wishes. It is impossible to explain matters to him; teach him to obey, and let him learn by observation why he is required to do so. Obedience implies self-control. All progress, mental and moral, must be regulated by the greater or less amount of self-control. A deaf child may give a telling blow; unable to hear it, he fails to realize the degree of force exerted. How shall he be taught he has done wrong? By a blow directed to him? That would teach him that what he gave another can hurt, but what does he think of the adult who strikes him? Would he not be likely to feel that the older person by giving a blow practically indorsed its use? The next step would be to reason that it is justifiable to give one, but well to avoid receiving another in return. The best way to punish and thus teach the child to drop lawless expressions of his displeasure must be to show one's power without a trace of anger. If he is held firmly in a chair despite struggles and cries he will realize he is being controlled. He is conscious of his act and knows he is deprived of his liberty in consequence. He sees determination but no anger in the face of his instructor, and learns that tears and screams are unavailing. There is no need to indulge in such useless efforts. He has tired himself, only to find his keeper fresh and undaunted. A slap would have suggested retaliation. Pinching could be easily returned. This superior, calm strength is something different and so far beyond his own abilities as to compel respect. In time the expression in the face is sufficient to enforce obedience, and the hands need rarely exert their firm, strong hold. The child's conscience is formed by the series of impressions he receives from the decided approval or disapproval in the faces about him. There may be times when more severe punishment is required, but rarely if proper training is received in early life. It should be remembered that the deaf child is not conscious of the effect of the unpleasant screams and resounding kicks he may give when he throws himself down some day in temper. All his dramatic exhibition may have less behind it than has the "No, I won't!" of the hearing child. We admit that the scene made by one and the attitude of the other are equally unpleasant, but the

second may reveal greater defiance than the first. Speech is the expression of feeling, and feeling is best aroused through the hearing. Here is a means of cultivation cut off from the deaf. Can the education of the eye ever become sufficiently developed to atone for the loss in this direction? Most certainly not. The diversion made by hearing a remark, a laugh, a song, or a musical instrument has oftentimes prevented a quarrel, dissipated a worry, or broken a willful determination. The deaf are deprived of this means of receiving a fresh turn to thought, and this fact should be borne in mind when it is noticed that their disposition is not to give up a plan once adopted.

What the deaf may become if untaught is not an agreeable picture to face. Some idea may be formed by recalling that they were classed among the idiotic in the years they were neglected and deemed unworthy of efforts to educate. Here is a child, bright, healthy, and active, with an avenue to his brain obstructed. Reasoning from limited knowledge gathered by his observations alone, he misunderstands many efforts to do well by him. He is conscious of lack of communication with others; in a little while he may be morose and unhappy. Give him the speech he knows not, and the language that is to him a sealed book. With care during the first years it is possible to develop an agreeable voice. It would be wrong to claim it can become always musical or perfectly natural; just as wrong is it to assert that some voices happen to be good, some acquire peculiar tricks for which there is no remedy, or that it is right to be satisfied with any vocal efforts obtained. The exhaled breath pushing its way between the edges of the glottis becomes voice. If poor, it must be so from incorrect action of the edges; if good, from correct action. The teacher who understands how to secure the proper working of this delicate instrument can give the pupil a good voice. Speech is related to the affections more than to the intellect. The prompting of the actions of the vocal organs comes from the stirring of some emotion. If the intensity is great, cool judgment has no influence upon the voice unless long experience has developed self-control; if fear or timidity is felt, results are noticeable immediately. The deaf child's happy state is therefore absolutely the first essential for securing a warm or affectionate tone; next, his thoughts must be thrown out away from himself to enable the organs to act without tension. It is for this reason we are not impressed with the wisdom of educating the touch of the finger tips to feel the vibrations of the vocal cords, believing as we do that such a method by centering attention upon the throat, a part of the pupil's body, prevents the developing of pure, resonant tones.

The voice formed in the larynx is molded into the numerous vowels by various shapes assumed by tongue, lips, and soft palate,

and into consonants by decided actions of the same organs. Compare voice thus changed to a stream of water lazily moving amid green banks, now cutting its way through rock, broken into rapids or plunged over a precipice. The smooth running is like the vowels formed by open positions molding a steady current of voice; the breaks and plunges like the consonants formed by actions producing friction or even obstructing the breath momentarily. Vowels are the life of speech; in them lies expressive voice. The consonants are the receptacles giving temporary limits to the vocalized breath. Thus the secret of agreeable voices among the deaf is instruction based on a realization that all useful exercises in vocal culture should be founded upon perfect action of the edges of the glottis. This assured, vowels and consonants combined, forming words, may be learned as rapidly as they can be memorized. The hearing child has listened months before attempting to talk, gradually gaining confidence to use his own organs, and as nearly as possible imitating the sounds about him. Very crude are his first efforts, differing widely from his speech model. Yet no one doubts his ultimate success. Let the same confidence be manifested with the deaf child in his first lessons. Care in securing correct positions for sounds brings out lines of beauty in his face, previously disfigured by unpleasant and unnecessary movements.

How is the pupil to know the meaning of the words he learns? It is necessary to explain by the natural signs he employs; consequently his first spoken and written words must be equivalents of the same objects he has designated by a gesture, of the daily actions about him, of the qualities he has appreciated by taste, touch, and smell. Single words thus become intelligible to him. He drops the sign and speaks; his vocabulary constantly enlarges. Now a new difficulty presents itself. The grouping of words, the forming of phrase and sentence, he has no knowledge of; moreover, when grouped he does not grasp the shades of meaning thus conveyed to the hearing person. He is likely to say "Sugar like," to express his fondness for the sweet; "Horse car go" to him means "I will go in a horse car." He has no use for *a*, *an*, and *the*, is contemptuous of the changes in tense, and is baffled by idioms. No one can realize without experience the need of patience and ingenuity in the teacher who imparts language to the deaf child; no one can have sufficient of these qualities who does not strive to keep in mind the pupil's limited range and thus bear with his ignorance. The hearing person studying a foreign tongue has his own language to help him. Grammar can be remembered because similar or dissimilar to his own; arrangement of words, by resemblance or want of resemblance to the forms in his daily use. Nothing of the kind is present to aid the child born

deaf; he knows no reason why words should be arranged in certain orders. Day by day the same forms are repeated until, brought into play on every appropriate occasion, they are used spontaneously. Fortunately, the scholar does not know what is before him. Ignorant of the amount he is to learn, he absorbs his daily allowance of language, his ideas expanding, and his mind unfolding. All is delightful to him. It is the teacher who feels the great work to accomplish. Various studies can be taken up by the pupil after he has secured some hold of language and his education can be made identical with that of a hearing student. There are no limits for him but his inclinations or circumstances.

A large number of the deaf were not born in their present condition; statistics prove that many have lost hearing by disease or accident after learning to speak in the natural way. If this should occur when two or three years of age, or when even somewhat older, and no educative means are employed immediately, the speech becomes impaired in a short time. Should the child be ten or more years old, he retains his articulation fairly well, but in common with those younger, the voice rapidly acquires unpleasant characteristics. Such children in former years were silenced in the institutions. Their knowledge of speech and remembrance of forms of expression in language develop into a great advantage over those of the same age who never heard. The difference is inestimable. There is far less chance for misunderstandings, less mystery about ordinary matters; the mind is older. The impaired speech may be corrected, the voice brought under control, and instruction in speech-reading imparted at once.

Formerly the ability to understand what is said by movements in the face was called lip-reading; the term is unsatisfactory, for more than the lips must be watched. Of late this accomplishment has received the name of speech-reading. It is an ability to follow the varying expressions in the face as quickly as they appear, and thus to convey thought through the medium of the eye instead of by the hearing. Persons reading the above will look up at some one present, and after watching the face awhile will wonder how it is possible for any being to follow those movements and understand speech thereby. They attempt too much at once. Preliminary steps must be taken. The little child just beginning to read can not scan a page quickly. Success in speech-reading means an education of the eye secured by practice. Its attainment by the child born deaf grows with his knowledge of spoken language; the child who has lost hearing after having learned speech naturally, advances in ability to understand others in proportion to his dependence upon that method of communication. The wonderful organ which gives

us so much happiness, and which we find early in life carries messages to the brain in behalf of some sense lying dormant, must concentrate its gaze upon a small space, the human face. The range being limited, more detail is noticeable; attention is not diverted by general movements embodying arbitrary or natural signs, to the hand and arm, or to the whole figure. There is an opportunity to increase constantly an appreciation of shades of expression just as a discernment of the nice distinctions of well-chosen words is attained. The result is, the deaf child follows in the face of a reader the details of a story with all the relish the hearing would in listening. There is no staring, simply a quiet, steady gaze. The repeating of the words seen, proves the close connection between the eye and the speech-center.

There is no doubt many children born deaf have hearing sufficient if educated to enable them to receive correct impressions through that sense, and to be in a condition similar to that of so-called hard-of-hearing persons. One reason they do not use the ear to better advantage is that they are ignorant of linguistic sounds. The adult losing his hearing power has the advantages of a full vocabulary, a knowledge of the structure of the language, and a mastery of its idioms, combined with an ability to hold conversation in his own hands; he can learn speech-reading, which with him is a high degree of expression-reading, and he need not change his vocation or pleasures, save those requiring a somewhat sensitive condition of the auditory sense. It would be far otherwise if he had to secure language with the small amount of hearing he now possesses. Many children are deaf because of a slow perception of sound, without reference to any functional disability. They must be taught to listen, for without the strain of attention the loudest noises may be unheeded. The work of opening to them an appreciation of the world of sound is called development of hearing, and is thus designated to distinguish it from improvement of hearing; the latter is an assistance to deafness arising from a diseased condition of the ears, and is rendered by various mechanical aids, such as noise, hearing tubes, and trumpets. In developing hearing, progress depends upon using the auditory sense alone. When the vision and hearing work together in aural instruction, there is an unnatural dependence of the latter upon the former, and no regard paid to the hereditary tendencies to action between ear and speech-center. The result is that the pupil seldom understands a new word unless he first sees it upon the lips. After instruction which compelled the hearing to rely upon its single efforts the various sounds of the language are appreciated immediately in any order given; as all words are but rearrangements of the same elements, new ones can be repeated as readily as familiar ones. The strain of attention being

undivided, ability to hear sounds at a longer range grows somewhat. Noise acts as an irritant in these cases instead of aiding as in deafness due to disease.

With speech and speech-reading attained, and perhaps the happy addition of some perception of sound, the deaf need not be thrown together as a class distinct from others. They may and do receive instruction in common with their hearing friends, attending leading schools and entering professional duties side by side with them. Such persons have been charged with an unwillingness to associate with the other deaf. Lack of interest in their welfare we do not believe possible, but a preference for the companionship of the hearing proves the existence of a satisfying method of communication. All are easily influenced by surroundings, and if deprived of any particular sense, especially so. The deaf need every advantage possible, and not the least of them should be adjudged daily intercourse with the most evenly balanced characters, persons possessing a normal development of all the senses.

LOGICAL METHOD IN BIOLOGY.

By FRANK CRAMER.

THE logical processes involved in scientific reasoning are the same in kind as those used in the everyday life of the masses. The difference between the two lies in the clearer recognition of the processes and their importance in the scientific field. There is nothing like exactness in the applied logic of everyday life, and the reasoning of science is superior to the "common sense" of mankind only in being more exact. In science the comparatively little work that survives and does not have to be done over and over owes its superiority to this same exactness. Science has no peculiar method of its own either of discovering facts or of treating them.

Scientific students spend little time on the consideration of logical processes, because the mind follows them instinctively; and the study of them, for practical purposes, seems to be superfluous. But apart from the fact that they present a set of phenomena as worthy of scientific treatment as the phenomena of light or of the molluscan nervous system, it is important to consider them because of their direct bearing on every department of science. Even the best established sciences have reached their present states by successive approximations toward exactness, by the gradual elimination of errors of both fact and method; and even the novice knows that the degree of confidence placed in the statements of fact of a

scientist by his contemporaries or succeeding generations depends directly on their confidence in his method. The history of any biological problem will furnish material for a comparison of methods. The present state of the problem will be found to owe its superiority over any earlier stage not simply to the greater number of facts that can be brought to bear upon its solution, but chiefly to more exhaustive methods for the discovery of new facts and interpretation of old ones.

There are comparatively few models that will serve as illustrations of the applied logic of the sciences, or of a sound and complete scientific method. Apart from quantitative exactness, the problems of biology can be given the same rigid application of logical principles as any other science; and in recent years much progress has been made toward giving numerical expression to both facts and laws in biology. The two following examples of scientific method—the one from experimental physiology, and the other from invertebrate morphology—show themselves, on analysis, to be models of vigorous generalization and deductive inference, prompt verification, reinterpretation of old facts, explanations of old contradictions, and removal of old obstacles to a clear understanding of the matters in question.

Fifty years ago Arnold discovered that the iris of the eel's eye contracts, producing contraction of the pupil, on being exposed to light after the eye is cut out of the head, and even when the anterior part with the iris is separated from the posterior part of the eye; but that when the outer or ciliary rim of the iris is cut away no reaction follows. It seemed to be conclusively proved that in the production of the phenomenon light acts directly on the ciliary part of the iris. A few years later Brown-Séquard discovered the same reaction in the frog's eye, and inferred that the light acts directly on the muscle elements of the iris. This inference he left entirely without verification, and even asked himself, without trying to answer, the question why, if light acts directly on the muscle fibers of the iris, it does not act thus on the other muscles of the body. In 1854–'55 Budge, after apparently exhaustive experiments, denied that the pupil of the excised eye contracts when light falls on the iris and not on the retina. In 1859 Müller proved that light acts directly not only on the outer rim of the iris, but more intensely on the inner or pupillary part. After a lull of twenty years in the dispute, Edgren proved that after destruction of the retina there is no reaction at all, and that therefore light does not act directly on the iris. The only fact that remained undisputed in this strife of fifty years was that the pupil of the excised but otherwise unmutilated eye of frogs and eels contracts when the eye is exposed to the light. It was still unproved whether the phenomenon is due to an intraocular reflex

which involves the retina or to direct action of light on the iris. The latter view was the favorite one, but no efforts were made to characterize the elements of the iris on which the light acts, and so to clear up the physiological conditions of the phenomenon.

"Stick to the facts!" impetuously shriek many biologists when some luckless fellow insists that scientific method, with the principles of logic at its foundation, requires careful and incessant attention in biological investigation. In this case the sequel shows that there can be no doubt of the truth of any of the statements made during the whole fifty years. But vociferous discussion could not remove the contradictions, and experiment only multiplied them. Confusion is as consistent with facts as harmony is. It was the lack of a clear logical analysis of all the conditions of the problem that led to the contradictions. Nothing was demonstrated until these were removed, and it is an important fact that they were finally removed, not by disputing them, but by reproducing the conditions of the contradictory experiments and incorporating the contradictions themselves into the final solution of the problem.

Steinach,* by his recent experiments, demonstrated that the sensitiveness of the iris varies immensely in different individuals of the same species; that the iris of frogs, kept for days in glass cases, does not respond at all to alternate shading and exposure to diffused daylight, but slightly to concentrated gaslight, and gives a regular reaction of appreciable amount only on exposure to concentrated sunlight; that when frogs are kept for a long time in the dark the iris responds promptly to diffused daylight; but if, after the light has produced contraction of the pupil, the frog, instead of being put back in the dark, is left exposed to the light, the pupil gradually dilates in spite of the light, and after some hours acquires a state of comparative insensibility, so that moderate changes in the light produce no changes at all in the iris; and that the difference in pupillary reaction between frogs kept in the dark and frogs exposed continuously to light is greater in the excised than in the normal eye, greater still when the iris is isolated from the rest of the eye, and that, while in frogs of medium excitability of iris the isolated eye still responds to light after shading, the iris, when separated from the rest of the eye, no longer responds even to the strongest light. One would think that at least some of these preliminary conditions of success would have thrust themselves upon the attention of the earlier investigators if they were not altogether lacking in the qualifications of true scientists. They were probably no more lacking in analytical

* Investigations on the Comparative Physiology of the Iris. II. Pflüger's Archiv für Physiologie, vol. lii.

power than any other set of investigators, but they had certainly not made the most of it. Steinach exhausted the conditions by taking into account, one at a time, the different degrees of inherent excitability, effect of exposure to and exclusion from light, and the reactions of the normal eye, the excised eye, and the isolated iris, against the different degrees of light, thus:

- Frog's eye.
  - High excitability.
    - Excluded from light.
      - Normal eye.
        - Diffused light.
        - Concentrated gaslight.
        - Concentrated sunlight.
      - Excised eye.
      - Isolated iris.
    - Exposed continuously to light.
  - Medium excitability.
  - Low excitability.

Etc.

These do not include all the conditions which he detected, but they are sufficient to indicate the difference between his method and that of his predecessors. The modifying conditions were not discovered in the order in which they appear in the table, but tabulation shows very quickly whether or not they have been exhausted.

When all the favorable conditions were combined there invariably resulted a characteristic contraction of the pupil, on exposure to light, whether the object experimented on was the normal eye, the excised eye, the isolated iris, or the isolated iris deprived of its ciliary rim. In other words, the contraction of the pupil in the excised eye of fishes and amphibia does not depend on an intraocular reflex involving the retina, but on the direct influence of light on one or more of the elements of the inner or pupillary part of the iris. It had been suggested that the phenomenon was due to the action of light on the endings of the nerve fibers in the sphincter muscle of the iris. Steinach removed this suggestion from the group of remaining possibilities by paralyzing the nerves of one eye of an animal with atropine and leaving the other normal, and showing by comparative tests that the two eyes continue to act alike. He showed by a special experiment that the posterior pigment layer of the iris has nothing to do with its contraction. The branched or stellate pigment-cells—the chromatophores—in the front part of the iris were possible factors in the problem. They were known to undergo changes due to the action of light. Light causes a redistribution of the pigment within the cell, causing it to collect at the center. When the eye of an animal which has been kept in the dark is alternately shaded and exposed to the light, there follow a prompt alternate dilatation and contraction of the pupil. This process can be carried on for some time before there is any visible change in the chromatophores; at the end of half an hour or more the chro-

matophores are "contracted," but the pupil contracts and dilates as before. Therefore the contraction of the iris is independent of the changes in the chromatophores.

At this point physiological experiment had to be abandoned, and it would have been extremely comfortable for Steinach to do as one of his predecessors had done—ride the rest of the way on a cantering hypothesis; but he appealed to histology. In his effort to determine in what other parts of the iris there was pigment, through which the light must produce its effect, he found that his judgment was confused by particles of pigment from the posterior layer, which were scattered at random over his histological preparations. This difficulty was obviated by removing the posterior layer of pigment before making the sections. After taking this precaution he showed that there is no ordinary pigment in the stroma of the iris; neither are there any ordinary smooth muscle fibers like those in the iris of the higher vertebrates. He found the sphincter muscle of the iris composed of spindle-shaped *pigmented* cells. That these are really muscle fibers he proved by their form, size, characteristic fibrillar structure, and function. It was impossible to observe directly the contraction of these fibers; he adopted the indirect method of killing the iris in the relaxed and in the contracted states and observing the condition of the fibers in each. In the former they were slender and narrow, in the latter shorter and thicker. The ciliary muscle fibers are not pigmented, and this accounts for their being indifferent to the light. His general conclusion is that light produces contraction of the isolated fish and amphibian iris by acting directly on the fibers of the sphincter muscle through their pigment.

The striking characteristic of this investigation is the exhaustive consideration and removal of alternative beliefs. His final conclusion is only an inference, and derives its "certainty" from the fact that it is the only belief that is left. In its relation to this conclusion the evidence is circumstantial. If now the reaction of the pigment and fibers could be directly observed, Steinach's conclusion would be set down as a verified prediction. Though unverified, it is unhesitatingly accepted, like so much of our "knowledge," as an important truth; for most minds its verification would add little or nothing to its certainty, and would even deprive it of some of its interest. This inferential knowledge forms a large part of scientific truth, and other instances of it will appear in the following example of method in morphology.

Various ciliated organs of unknown function in different mollusks had never been brought under the yoke of homology. One of the most decisive tests in morphology for the determination

of homology is the mode of innervation of an organ. Spengel* reasoned that the homologies of these organs could be best established by a comparative study of their modes of innervation—in other words, by discovering their relations to other organs known to be correlated in definite ways among themselves. In this way he succeeded in proving their morphological identity, although the belief that they are olfactory organs is based simply on the morphological fact that they invariably occupy a certain position in relation to the respiratory organs, and not on any physiological data.

He demonstrated the general occurrence of this particular kind of organ in the prosobranch gastropods, inferred that it ought to occur among the opisthobranchs, and succeeded in demonstrating its presence in the division of tectibranchs. He had already in his possession the hypothesis that the organ is one belonging to the mollusca as a whole and drew from it the deduction that it ought to be present in the lamellibranchs, among which it had not been hitherto known. He said: "The position in which such a one would have to be sought was clearly enough indicated to me by my observations on the gastropods. It would have to be in the neighborhood of one of the ganglia of the visceral commissure." Trusting this definite anticipation, he looked for the olfactory organ and found it in *Arca Noæ*, the first mussel he opened for the purpose. In this species the organ is characterized by pigment, which made its recognition easy. In other species that he examined the pigment is absent, and had he first opened one of these, he might have had a long and possibly fruitless hunt for the organ. This well illustrates how important a part chance frequently plays even in deductive investigation. It is interesting to note how the deduction might have remained unverified and possibly have been adandoned and yet have been a true one.

The organ typically consists of thickened epithelium innervated from a ganglion underlying it. Theory required the presence of a ganglion under the olfactory organ of lamellibranchs, but there was apparently only a strong nerve, which had hitherto been universally interpreted as the "gill nerve." Histological examination proved it to be an elongated ganglion inserted on the nerve between its origin and its ending in the gill. Here again, a deduction led to a discovery and the correction of what had seemed for years to be a settled fact.

Spengel had shown, in his study of other groups, that the nerve on which the olfactory ganglion lies arises from the vis-

* Die Geruchsorgane und das Nervensystem der Mollusken. Zeitschrift für wissenschaftliche Zoologie (April 22, 1881), vol. xxxv, pp. 333–383.

ceral ganglia inserted in the visceral commissure, and not from the pleural ganglia. With one stroke of deduction he swept away a whole brood of old views. He reasoned that the parieto-splanchnic ganglia of lamellibranchs, from which this nerve arises, must on account of this very fact be the visceral ganglia, and not what they had been universally assumed to be—the homologues of the pleural ganglia of gastropods. The old view necessitated the belief that the renal, reproductive organs, etc., of lamellibranchs are innervated from the pleural ganglia, and that the foot with all its accessories is included within the œsophageal ring of ganglia; whereas in other mollusks the renal, reproductive, and associated organs are innervated from the visceral ganglia and the foot lies outside of the œsophageal ring. If the parieto-splanchnic ganglia of lamellibranchs are homologous with the visceral ganglia of other mollusca all the above-mentioned organs hold the same relations in lamellibranchs as in the other groups. This reinterpretation of so many known facts harmonizes the lamellibranch type completely with that of the general molluscan type and marks a distinct step in the progress of molluscan morphology. He pursued a similar though less complete course with the cephalopods.

By this method of morphological reasoning, accompanied and corroborated or corrected at every step by morphological investigation, a heterogeneous mass of facts was bound together under the principle of homology, and many new ones were discovered that would not have been brought into notice in any other way. Indeed, the principle of homology, together with the principle on which it depends, the correlation of organs, furnishes a basis without which it would be nearly impossible to make intelligent search for new facts. Incessant use is made of the general logical principle that things that are similar in some respects, are likely to prove similar in other and unknown respects, and that things similar in many respects are likely to prove similar in most or all respects, in anticipating biological facts. It is well known that many of the facts of greatest theoretical importance in biology have been overlooked until hypothesis pointed them out. Yet this power of prevision is one of the most dangerous of pitfalls. No rule can be laid down for the use of the principle, because there is none. There is a general precaution to be observed: similarity in a few respects is no warrant for inferring similarity in many respects, much less all respects. Too many biologists, among them some of the most eminent, seem to have a wrong conception of the function of this logical principle. Scholastic methods are the favorite butt of scientific wit, but that notorious old tendency to speculate without due regard to facts is not dead but only facing in another direction. The stupid blunders and

worthless "results" due to it are charged up against the far-reaching logical principle itself and have given rise to a counter tendency that is no more creditable. The old cry, "Stick to the facts!" simply means that the danger of going wrong increases very rapidly as one passes by inference beyond known facts, especially when these are few in number. Perhaps the greatest boon that could fall to biological science would be such a thorough study of the history of the science by its own votaries that they would learn beyond the power of forgetting the fact that speculation alone is worse than useless, and that reasoning with verification is indispensable.

INVENTION AND INDUSTRY AT THE SOUTH.

By BARTON H. WISE.

THE antagonism between the plantation interest on the one hand, and commerce and manufacturing on the other, was pointed out at an early period of our history. The institution of negro slave labor repelled white labor and immigration from the South; and while the North received continuous waves of population, and the growth of commerce and manufacturing caused cities to spring up in every direction, the South remained a sparsely settled section, almost purely agricultural. These conditions have been attributed in part to climatic influences, but this theory hardly holds when we reflect that what we call the South is not only part of the Northern continent and in the temperate zone, but that its southernmost point is seventeen hundred miles north of the equator. So much did the increase of population in the South, however, lag behind that of the North, that in 1850 there were in the former only 18·93 inhabitants to the square mile, to 45·8 in the latter. Not only could capital at the South be more profitably invested in lands and negroes than in manufacturing, but in addition efforts at establishing manufacturing plants were unsuccessful, as negro labor was not suited to it.

In considering the subject of inventions at the South, we can not afford to overlook these facts, nor can we overestimate the depressing effect that negro labor was calculated to produce, though indirectly, upon the inventive faculties of the people. In the North every circumstance tended toward the encouragement of manufacturing, and among a people who, as a consequence, were accustomed to the use of machinery of all sorts, the inventive faculties were stimulated to their utmost.

In the South these conditions were exactly reversed, and nothing tended to the growth of manufacturing or of an urban popu-

lation. If we except Baltimore, Louisville, and St. Louis, neither one of which is an exclusively Southern city, New Orleans remains even to-day as the only city in the South of over one hundred thousand inhabitants. Neither Richmond, Atlanta, Charleston, Memphis, nor Nashville has a white population of fifty thousand. With these various conditions borne in mind, it is not strange that the talent of the Southern people was exercised in other directions than those of inventions.

The military qualities of Southerners have been demonstrated in every war in which the United States was engaged; and the leadership in the Revolution, the second war with England, the war with Mexico, and on the Confederate side during the civil war, fell to the part of Southern men. Even on the Northern side during the last-named contest numbers of the foremost soldiers and sailors were men of Southern birth, prominent among whom may be mentioned Thomas, Ord, Fremont, Newton, and Farragut. Abraham Lincoln, the head of the civil administration during the same period, was a born Southerner, and Grant was of Southern extraction. In statesmanship the South had held the highest rank always, and under Southern leadership all the additions to the national domain were made. His English ancestry, the republican form of government under which he lived, the call of a new country for political thinkers during its formative period, the passion for governing engendered by the ownership of slaves, and lastly the long antislavery agitation which saturated the atmosphere with politics, all contributed to cause the ambitious Southerner of the past to drift into public life. The descendants of the Jamestown colonists inherited the Anglo-Saxon spirit of adventure which characterized their ancestors, and it is not strange that Virginia led the rest of the States of the Union in the number of her pioneers who settled the West and Southwest. While all this is true, the talents of the South were largely confined to these channels when exerted at all, and the ability of the North, as has been said of it, "sought expression in a wider range of subjects than that of the South." Conditions at the South were not favorable to the growth of literature, art, or invention, and there being no cities of large size, there were hence no common centers of activity, where either literary workers, artists, or scientists could be sure of employment, and be in contact with sympathetic minds following kindred pursuits. Edgar Allan Poe toiled away at Richmond as editor of the Southern Literary Messenger, but was compelled finally to drift northward to maintain a livelihood. William Gilmore Simms, the only man of note in the South, besides Poe, who followed literature as a profession, plodded along in South Carolina among a people who afforded him little encouragement, and his numerous efforts to

found a literary magazine in Charleston all met with failure, despite the fact that an unusually cultivated society dwelt in that city. Washington Allston, after finishing his art studies in Europe, located in Boston, which was able to hold out to him greater inducements than the little city of Charleston, the metropolis of his native State. Gottschalk, the composer, whose dreamy, sensuous music suggests his Southern birth, after finishing his musical course in Paris, made his *début* there, and died finally in Brazil, spending but little time in New Orleans. Audubon, with his dog and gun, and his pencil and drawing pad, searched the woods and bayous of his native Louisiana for his specimens of birds and natural history that were to win for him the name of the greatest naturalist of the New World. But he labored under adverse conditions, and he had to canvass the large cities of Europe for subscribers to enable him to publish his book on the birds of America, the greatest ornithological work ever undertaken. This he brought out at New York in 1830, with plates containing over one thousand birds of life size, and Cuvier pronounced it "the most magnificent monument that Art has yet raised to Nature."

In the Constitutional Convention of 1787, James Madison, of Virginia, and Charles Pinckney, of South Carolina, proposed the clause protecting authors and inventors, which was the foundation of our copyright and patent-right system. The Patent Office was organized and placed on a firm basis largely through the efforts of Jefferson, who is credited with being its founder, and later on it was reorganized and perfected during Jackson's administration. Jefferson was himself an inventor, being the first American to study and improve the plow. The year 1789 is memorable as the date upon which Rumsey, a Maryland machinist, then living in Virginia, launched his boat upon the Potomac, propelled by steam, Fitch performing a similar experiment upon the Delaware about the same time. Later on, in 1792, Rumsey went to England and made a successful trial trip on the Thames. This same year Eli Whitney, a young New-Englander, invented his famous cotton gin, that may be said to have revolutionized the history of the South and the Union. As an illustration of the scarcity of manufacturing and mechanical establishments in the South at that date, it may be mentioned that Whitney had to draw himself the iron wire he needed and make his own iron tools at the plantation of Mrs. Greene, the wife of General Nathanael Greene, on the Savannah River, where he was residing. It is a notable circumstance that the first canal in America of any consequence, the first telegraph line, and the first railway propelled by steam were all constructed in the South, and the first steamship to cross the Atlantic embarked from a Southern port. The first canal of im-

portance was the James River and Kanawha, which began at Richmond, and was designed to connect the Chesapeake Bay with the Ohio River. It was proposed by Washington and begun in 1785, and afterward carried as far westward as Buchanan in Virginia. During the year 1818 leading merchants of Savannah, Ga., had constructed, through the advice of Captain Moses Rogers, of that city, a combination steam and sailing vessel to run between Savannah and Liverpool. The machinery and engine were built in New York by Daniel Dod, a Virginian, who had moved to that city, and on the 20th of May, 1819, this vessel, which was christened the Savannah, steamed out of the Savannah River for Liverpool, making the first transatlantic trip by a steam vessel in twenty-two days. It created a great sensation in England, and "the people crowded the Mersey's banks filled with surprise and admiration when she entered the harbor of Liverpool under bare poles, belching forth smoke and fire, yet uninjured." From Liverpool the Savannah steamed to St. Petersburg, where it aroused the curiosity of the Czar, and attracted great attention. The log book and cylinder of the vessel are at present on exhibition in London. Charleston secured in 1827 the first railway charter granted in the South for the South Carolina Railroad; and when a few years later it was completed to a point on the Savannah River, opposite Augusta, called Hamburg, it was one hundred and thirty-six miles in length, and the longest line of railway at that time in the world. The directors of this road determined as early as November, 1829, to make steam the sole motive power, which had not then been adopted elsewhere in America, and the first locomotive constructed in the United States, which was called the "Best Friend," was planned for this road by E. L. Miller, of Charleston. The South Carolina Railroad was the first steam railway to carry the United States mail, and the system of double-truck running gear, including the application of pedestals to the springs, which was later on copied by all the railroads, was instituted by Horatio Allen, their engineer. Strenuous efforts were made in the South in the way of railway construction, but in a sparsely settled section the rate of increased mileage naturally fell far short of that in the more densely populated North. The inscription on the bust of Robert Y. Hayne, in Charleston, records that "his last public service was his effort to open direct communication with the vast interior of our continent." "Next to the Christian religion," said Hayne, "I know of nothing to be compared with the influence of a free social and commercial intercourse in softening asperities, extending knowledge, and promoting human happiness." He might at this particular period have named one thing more potent even than railways in uniting the different sections of the country—namely, the

doing away with the system of African slavery, for which, though the South was not responsible, it having been fastened upon her by the greed of England and New England, yet which blighted her industries and made her isolated in her modes of thought and out of touch with the world at large.

Despite the fact that the people of the South were but little engaged in scientific or mechanical pursuits, and that their intellectual energies have for the most part been absorbed with other thoughts, yet many notable inventions and contributions to science have been made by Southern men. Cyrus H. McCormick, a native of Rockbridge County, Va., and the inventor of various agricultural implements, among them his famous reaper, received the thanks of the French Academy of Sciences for having done more for the cause of agriculture than any other man living. "Owing to Mr. McCormick's invention," said William H. Seward in 1860, "the line of civilization moves westward thirty miles each year." Richard J. Gatling, of Hertford County, N. C., devised various machines and the "Gatling gun," now an arm of the United States service and adopted by foreign governments as well. Both McCormick and Gatling moved West—the former to Chicago and the latter to St. Louis—the country districts of Virginia and North Carolina affording them poor fields for their endeavors. Henry J. Rogers, a Baltimorean, was the practical adviser and assistant of Morse in the construction of the first telegraph line in the United States, which was built in 1844 between Washington and Baltimore. He was the superintendent of it and made many improvements in it, and was the inventor of several telegraphic instruments. Rogers also devised the first system of pyrotechnic signals in the United States and the one by means of flags that was adopted by the navy in 1846. The author of international fog signals was Samuel P. Griffin, of Georgia; and the inventor of the first complete system of ciphers used by the associated press was Dr. Alexander Jones, of North Carolina. The name of Maury stands above that of every other Southerner, if not of every American, in his contributions to science. Maury's writings demonstrated that meteorology could be raised to the certainty of a science, and Humboldt credited him with being its founder. He was also the first to give a complete description of the Gulf Stream and to mark out specific routes to be followed in crossing the ocean, which won for him the name of the "pathfinder of the seas." In addition to these he founded the method of deep-sea sounding, and his letters to Cyrus W. Field, now in the National Observatory at Washington, prove him to have been the first to suggest the idea of connection between the two continents by means of a cable on the bed of the ocean, and the present cable was laid along the lines pointed out by him. The plan of splicing the

cable in mid-ocean was devised by Dr. James C. Palmer, of Maryland.

The limits of this article do not admit of giving a list of all the Southern men who have made inventions of note. Some of them are John Lawrence Smith, of South Carolina, the celebrated mineralogist and inventor of the inverted telescope; "Sibley, of Louisiana, and his conical tent; Gibbs, of Virginia, and his sewing machine; Janney, of Virginia, and his car coupler; Gorrie, of Louisiana, and his ice machine; McComb, of Louisiana, and his 'arrow' cotton tie; Gaynor, of Kentucky, and his fire telegraph; Stone, of Missouri, and his grain roller mill; Remberts, of Texas, with his roller cotton compress; Clarke, of Texas, with his envelope machine, and Campbell, with his cotton picker; Bonsack, of Virginia, with his cigarette machine; Coffee, of Virginia, with his tobacco stemmer; Stevens, of Florida, with his fruit wrapper; Law, of Georgia, with his cotton planter; Avery, of Kentucky, with his plow sulky; Watt and Starke, of Virginia, with their plows; McDonald, of our own day, with his fish ladders and hatcheries, filling our streams with fish." Henry Draper, a Virginian by birth, who removed to New York, made what has been called "the most original discovery ever made in physical science by an American." He was an authority upon telescopic work, and his experiments in his specialty of celestial photography led to the discovery of oxygen in the sun by this means and a new theory of the solar spectrum.

In the practice of medicine the Southern physician was under the disadvantage of having thinly populated country districts as the field of his labors, and he lacked the benefits of association and co-operation with those of his own calling that a city physician enjoys. But his isolated situation, as has been said of him, often stimulated boldness of thought and original investigation. Ephraim McDowell, M. D., a native of Rockbridge County, Va., and who had moved to the little village of Danville, Ky., performed here in 1809 the first operation on record for the extirpation of the ovary—an announcement received with incredulity in Europe, but the truth of which was established, and which won for him the title of the "father of ovariotomy." Crawford W. Long, M. D., a Georgian, performed in Jefferson County, his State, on March 30, 1842, the first surgical operation on record, with the patient in a state of anæsthesia, which was produced by the inhalation of sulphuric ether. Of a like class of men was J. Marion Sims, M. D., of Alabama, the pioneer in gynæcology and abdominal surgery. The eminent surgeon, Dr. Hunter McGuire, whose position as Medical Director of Stonewall Jackson's corps, Army of Northern Virginia, gave him exceptional opportunities of information, said of the surgeon in the Confederate army: "His

scanty supply of medicines and hospital stores made him fertile in expedients of every kind. I have seen him search field and forest for plants and flowers whose medicinal virtues he understood and could use. The pliant bark of a tree made for him a good tourniquet; the piece of a green persimmon, a styptic; a knitting needle, with its point sharply bent, a tenaculum, and a penknife in his hand, a scalpel and bistoury. I have seen him break off one prong of a common table fork, bend the point of the other prong, and with it elevate the bone in depressed fracture of the skull and save life. Long before he knew the use of the porcelain-tipped probe for finding bullets I have seen him use a piece of soft pine wood and bring it out of the wound marked by the leaden ball. Years before we were formally told of Nélaton's method of inverting the body in chloroform narcosis, I have seen it practiced by the Confederate surgeon. Many a time I have seen the foot of the operating table raised to let the blood go by gravitation to the patient's head when death from chloroform was imminent, and I will add that in the corps to which I was attached chloroform was given over twenty-eight thousand times, and no death was ever ascribed to its use." The talents which the stern necessities of war called forth in medical science were exhibited in every other department by the Southern people. It has been said that "one of the compensations of war is a swift ensuing excitation of the mental faculties," and in this instance it would seem to have been so. The outbreak of the civil war in 1861 found the seceding States with a population of eight millions, about one half of whom were negro slaves, as against twenty-four millions in the non-seceding States. The disparity in population between the two sections, however, great as it was, was not greater than that of their equipment in the implements of warfare. A widely separated, almost exclusively agricultural people, without manufactories or skilled labor, were to contend with a people accustomed to the handling of machinery of all sorts, operated by the highest class of trained mechanics, and in whom the inventive faculties had been developed to their utmost. One of the greatest curses of negro slavery was not only that it was in itself an inefficient labor for the higher classes of work, but it also served to drive out white labor of the better sort, which invariably shunned the black districts. A striking instance of the scarcity of skilled labor in the South was furnished in the matter of making gunpowder with which to carry on the war. In the spring of 1861 Mr. Davis authorized Colonel George W. Rains to undertake the construction of powder works for the Confederacy. These mills, begun in September of that year at Augusta, Ga., were finished the following April. For the first year of the war the Confederates were almost entirely dependent upon the powder captured from

the enemy, and more than once military movements were hampered owing to the scarcity of ammunition. We have it upon the authority of Colonel Rains that "but one man—Wright—could be found in the Southern States who had seen gunpowder made by the incorporating mill, the only kind that can make it of the first quality; he had been a workman at the Waltham Abbey Government Gunpowder Works in England." During the period that the Augusta mills were in process of construction a small powder factory was run at Manchester, Tenn. The output of this was very limited, and it was conducted mostly as a school of instruction, and as soon as the Augusta works were completed the operatives and machinery were transferred there. At the same time, at a refinery in Nashville, workmen were being taught to refine saltpeter and distill charcoal. Notwithstanding these methods of obtaining competent labor, it was with the greatest difficulty that a sufficient supply could be procured, and as a consequence every sort of labor-saving device possible was adopted. Among the improvements introduced by Colonel Rains in this way was a crystallizing machine of his own invention for refining saltpeter, the main constituent of gunpowder, and which has to be brought to a high state of chemical purity. By means of this machine eight or ten thousand pounds of saltpeter, used by the works daily, which had to pass through many stages and undergo much manipulation, which at first required a large force by manual labor, was prepared by two or three workmen. Other improved methods of powder-making were brought into use for the first time, and the Confederate powder works were pronounced among the finest in the world, and the London Times and other foreign papers gave lengthy and commendatory descriptions of them.

The Confederacy was furnished with one thousand three hundred and seventy-five tons of gunpowder from these works. Colonel Rains is authority for the statement that "notwithstanding the admirable serving of the heavy artillery at Fort Sumter during that engagement, it would have fallen and Charleston been captured had any but the strongest gunpowder been used. The armor of the ironclads, though constructed expressly to withstand the heaviest charges and projectiles, gave way before its propelling force." General G. J. Rains, a brother of Colonel Rains of the powder works, was the inventor of the sub-terra shells, that were first used after the battle of Williamsburg, and which proved effectual in retarding the advance of the Federal forces. At the time that McClellan was in command below Richmond, in 1862, and his vessels in James River, General Rains was placed in command of the submarine defenses by the Confederate Government. Here, opposite Drury's Bluff, the first submarine torpedo used in the war was made. This mode of defense had been previously

experimented with by the Russians in the Crimea, but it had proved ineffectual against the allied fleets. Under the spur of dire necessity the Confederates turned their attention to it, and it was brought to such a state of efficiency that Charleston, Wilmington, and Savannah maintained a successful defense till near the end of the war, despite the efforts of Dupont and Dahlgren to force an entrance through their harbors. Their destructiveness was demonstrated at many other points, and fifty-eight vessels, including ironclads, were destroyed by this means in Southern waters.

Shortly after the breaking out of the war, the naval department of the Confederacy began experiments of various sorts with floating batteries and naval rams, many of which were conducted under the supervision of Lieutenant Catesby ApR. Jones. The name of Lieutenant Jones, together with that of Lieutenant John M. Brooke, the inventor of the "Brooke gun," and deviser of the plan by which the hull of the frigate Virginia was converted into the ironclad Merrimac, deserve mention along with Maury and Buchanan, as being the men who probably did most toward rendering the naval appliances of the Confederates effective. English and French officers who witnessed the fight in Hampton Roads of March 8, 1862, when the Merrimac sunk what were then considered as among the finest war ships, remarked to a Confederate naval officer, Captain H. B. Littlepage: "We have not a war ship in our navy; a wooden ship is no longer a war ship; that fight will rebuild and remodel the navies of the world." "The British navy," says Captain Littlepage, "which cost hundreds of millions of dollars, was as effectually destroyed on that eventful 8th of March as was the noble old Cumberland, sunk to her topsail yards by the Merrimac's ram, a weapon practically unknown before. The 9th of March but emphasized the value and importance of iron-plated vessels, and illustrated two principles in the construction of war ships which must last for all time—i. e., the deflecting and turreted armors."

The Confederate Ordnance Department had at its head a highly competent officer, Colonel Gorgas, and through a system of rigid civil-service examinations a set of efficient men were obtained. In the early part of the war, before the blockade became stringent, ordnance stores were purchased in Europe, and these, with what were captured from the enemy, were used. Many instances might be cited to show the difficulties that were gone through with to supply the army, such as the making of percussion caps for the last year of the war (the Confederates being armed entirely with muzzle-loaders) out of turpentine and brandy stills gathered in North Carolina, the only copper mines in the South having fallen into the hands of the enemy. Another

illustration was the substitution of chlorate of potash and sulphuret of antimony for mercury to fill the caps, the latter not being obtainable. These and many other similar facts might be quoted to confirm the statement of Colonel William Leroy Broun, the head of the Richmond Arsenal, and at present the superintendent of the Alabama Polytechnic Institute, that "when we consider the absence of manufactories and machinery and of skilled mechanics in the South at the beginning of the war, its [the Ordnance Department] successfully furnishing ordnance supplies for so large an army during the four eventful years is a striking instance of the wonderful energy and resources and abilities of its people to overcome difficulties." We have but to look at the table of manufacturing establishments in the South at present, in comparison with past years, to realize the rapid increase in that line and the growth of skilled labor that must inevitably accompany it. From 1880 till the present there has been a wonderful forward movement. Data have not yet been collected in full by the Census Department for 1890, but the bulletins issued on the principal Southern cities all show a large increase in the number of plants of every sort, and the cities of Memphis, Nashville, New Orleans, Mobile, Charleston, Richmond, Norfolk, Savannah, Augusta, and Baltimore, all of them more than doubled, and some of them more than quadrupled the amount of capital invested in manufacturing enterprises between 1880 and 1890. Railroad mileage in the South increased from 23,811 miles in 1881 to 44,805 in 1891, and the number of cotton mills during the same period from 161 to 356. All of these facts speak for themselves, and need no comment to point out their influence upon the future. Another potent factor, in its influence in stimulating invention in the future, is the great increase in industrial and polytechnic schools in the South, and the attention now paid to the study of natural science, which was formerly neglected for the classics. As has been recently pointed out in an interesting article by Prof. Charles W. Dabney, in the early days of American history the preachers were the learned men and the leaders in educational work. Nearly all the older colleges were the offspring of the churches, and in the South this continued to be the case, not only down to the period of the war, but for a decade afterward. The University of Virginia, one of the few institutions not under church influence, was naturally the first to open advanced scientific departments. It may be mentioned also that this university was the first in the Union where the *elective* system was introduced, in contradistinction to the curricular method in vogue elsewhere. Harvard and other Northern colleges have in late years modeled their courses much after the Virginia plan. The South has also within its borders probably the first college in the

world to confer a degree upon a woman. The higher education of females was undertaken at an early date in Georgia, and the Georgia Female Institute, opened in 1839, is believed to have preceded both Oberlin and Mount Holyoke in granting degrees to women. Of late years there has been a marked improvement in the number and character of educational institutions of all sorts in the South, but the most significant change is in the number of technological schools, scarcely one of which was in existence twenty years ago. Prof. Dabney quotes the reports of the United States Bureau of Education for 1888 and 1889, which show that there were at that time "a total of twenty-eight schools, or departments of schools, giving regular instruction in science and technology, an average of over two for each State." If the list of patents taken out by residents of the different States for the past century shows that the South has been considerably behind in the race, the more recent statistics are suggestive of a different result in the near future. The following figures give the number of patents granted residents of the Southern States for the years named: 1860, 667; 1870, 1,469; 1880, 2,656; 1885, 1,633; 1890, 3,159.

If it be asked what in the future will be the effect of negro labor and the race problem on the South, the answer is that there will be no negro labor and no race problem, for the very good reason that there will be no negro there. This will doubtless strike the average reader as a bold and perhaps absurd prediction, but every circumstance points to its fulfillment. The idea is by no means new, and Jefferson, probably the profoundest political philosopher of his country, a strong opponent of slavery, and it should be added a resident of a slaveholding State, and whose knowledge of the institution was actual, not theoretical, long ago gave this as his opinion. He asserted that nothing was more certainly written in the book of fate than that the negro was to be free, and he added that it was equally certain that when free the two races would not continue to live side by side. This was also the view of Calhoun, who, while unlike Jefferson a proslavery man, held his opinion as regards the impossibility of the two races continuing together after emancipation. The industrial conditions of the South at present point clearly to the realization of these prophecies at a period not far distant. We hear and talk much of the conflict between capital and labor. We forget that the real conflict is not between capital and labor, but between labor and labor. No race has ever stood in the way of the Anglo-Saxon in his onward march, and it is not probable that the negro race, among the lowest in the scale of civilization, is to be the sole exception to that rule. As the poor white of the South, reenforced by the laborer from the North, enters more and more into the field as a competitor with the negro, the latter will meet

with an antagonist that must sooner or later press him to the wall, and in conformity to his racial instincts the African will move on farther and farther southward.

The number of farms at the South has increased rapidly since the war. This does not mean more land, but the subdivision of the larger estates of the past into smaller holdings, and an increase in the number of white yeoman farmers who do their own labor. Besides these circumstances, the census of 1890, contrary to the general idea, showed that the natural rate of increase of population among the Southern whites over the negro was almost in the ratio of two to one. The effect of this excess of white increase is apparent, and besides it is by no means probable that the white inhabitants of the South are not to be added to by large immigration from the North. The granting of the suffrage to the negro, partly through a misguided and in part a pretended friendship, will aid to further his displacement, for his aspirations as a politician have not been favorable to his success as a laborer and the betterment of his material condition. Neither the sword and bayonet nor plague and pestilence are necessary to a work of uprooting, for by a natural racial and economic law the negro will be driven out and supplanted by the white, and Louis Blanc's theory of extermination be illustrated as never before. There was a certain fitness in the emancipation proclamation being signed, when it came to be, by Abraham Lincoln, a representative of that class of Southern whites upon whom the institution of slavery had borne most hardly, and who were crowded out of the slaveholding districts. Time and the developments of the future will show more and more that in slavery the negro found his preservation, but the laboring white his curse. The historian Green tells us that after the Norman conquest there was among the English people "an immense outburst of material and intellectual activity," and that "the long mental inactivity of feudal Europe broke up like ice before a summer sun." It would be anything but correct to refer to the "mental inactivity" of the *ante-bellum* South, for in the lines that its talents were exerted it showed an ability fully equal to that of any other section, but the incubus upon its material growth, and the problems which then demanded its intellectual energies, are now in a large measure removed; and we may say of the South, as Green does of the England of King John, that it is "quickened with a new life and throbbing with a new energy." We need not fear the effects of an enervating climate or Southern sun. The upper tier of Southern States and the Southern Appalachian region form probably the best climate on the Atlantic side of the continent, and in the more Southern States, such as Alabama and Louisiana, while the summers are longer, yet the heat of the sun

is not as oppressive as in the North, though the air is as balmy as that of Italy. History does not show that a softer air and sky are less favorable to intellectual growth in any line than a more harsh and uncongenial clime. Italy is not only the land of Michael Angelo, of Raphael, and of Titian, but of Volta, Galvani, Torricelli, and Galileo as well, and the atmosphere that excites the imagination is as favorable to inventive genius, as applied to natural science or mechanics, as to painting, sculpture, or music. Of the Southern States we may say that no section of the Union gives promise of greater achievement; indeed, none is so rich in what the future has in store.

LEGAL PREVENTIVES OF ALCOHOLISM.*

By M. J. BERGERON.

WE have met to study together the means of combating alcoholism, to which we can not refuse the well-merited title of the scourge of the nineteenth century, for it has produced and is still producing more victims than the plague and the cholera combined. We all know that it is what multiplies assassinations and suicides, populates insane asylums, crowds hospitals, and contributes to the sterilization of the race. We are not here to repeat what has been said over and over again till it has become tedious, since the days of Magnus Hus, or to indulge in sterile lamentations over the ravages of alcoholism, but to seek a remedy for the terrible evil.

I do not bring you this remedy, but come to ask for it; for I hope that this congress—more fortunate than its predecessors—may be able, if not to shape the details of a law or of measures applicable to all civilized states, at least to point out, in a more precise fashion than has hitherto been done, a way to reach most promptly and surely the end we are all aiming for. We ought then, first, to inquire into what has already been attempted in some of the states of Europe: and I shall begin with the country I know the best, France, which has not, more than the northern states, escaped the invasion of alcoholism. It is of recent origin there, it is true, but its progress has been frightfully rapid; yet it was not till after the delirium and crime of the Commune, during which it played a terrible part, that our thoughts became fixed on the study of the means of arresting the spread of the scourge.

It was toward the end of 1871 that M. Théophile Roussel pre-

* A paper read at the Fourth International Congress against the Abuse of Alcoholic Drinks, held at The Hague in August, 1893.

sented and secured the adoption by the National Assembly of a law against intoxication; and about the same time, too, the Academy of Medicine commissioned me to prepare an Advice to the People on the dangers of the abuse of alcoholic drinks; and that the lamented Lunier, seeking to carry out practically a conclusion of my Report on Vinage, organized the French Temperance Society. But the law against intoxication, executed leniently from its promulgation, soon fell into desuetude; * the Advice to the People has been a dead letter; and I am obliged to confess that the Temperance Society, which decorated me after two years of presidency of it with the title of honorary president, in spite of the zeal and talent of its general secretary, M. Motet, drags on a precarious and obscure existence, and has, I believe, accomplished to the present time nothing more than to reward a few brave men who have remained sober, without diminishing by a single individual the number of drunken men.

The state has attempted to intervene in the struggle against the progress of the evil no further than to raise the taxes on alcohol to an amount which seems exorbitant, but is still much lower than the tax the English consumer pays; but this increase has exercised no influence on the consumption, which, on the other hand, has not ceased to advance, as it has also done in England since the establishment of the new taxes.

We might apparently base great hopes on the reduction of the taxes on the substances entering into the preparation of hygienic drinks, such as coffee and tea, and of the sugar tax. Indeed, I think that these are excellent measures, and of advantage to sober persons accustomed to these salutary drinks to the exclusion of intoxicating liquors; but I hardly believe that they are of such a nature as to cause drinkers of alcohol to give up their favorite beverage, or to secure youth, workmen, or others from the attractions of the inn, where more alcohol and distilled liquors are sold than wine.

The consumer can not be induced to use coffee and tea instead of alcohol, unless he can find in those hygienic drinks the excitation which alcohol and all the mischievous preparations of which it is the base will procure for him. Now, this excitation of the brain is the source of all the harm. To beginners, who as yet use alcoholic drinks with moderation, they give the agreeable sensa-

* In the first years following the promulgation of the law against public intoxication, there were drawn up annually from eighty thousand to ninety thousand indictments for violation; since 1885 the number of prosecutions has fallen off one half; it varies between forty-five thousand and fifty thousand; and it is to this relaxation in repression that we should attribute the diminution in the number of indictments, and not to progress in temperance, for the ravages of alcoholism keep on increasing.

tion of seeing everything on the good side, and of experiencing a momentary augmentation of strength. We should not be surprised, therefore, to find that people who have for the first time felt this sensation are tempted to seek it anew, and to ask of it continually a forgetting, even though it be only momentary, of the difficulties of life, of the fatigues of their occupation, and the illusion of a greater capacity for work which neither tea nor coffee will ever procure for them.

We might, therefore, regard the reduction of the duties on wines as a suitable measure for diminishing the ravages of alcoholism. I believe, in fact, that even the abuse of wine, supposing it to be pure from all addition of alcohol, is not so injurious as even the moderate use of alcoholic drinks; but, with wine the drinker will obtain the excitation he seeks only by drinking considerable quantities, while a small portion of alcohol suffices for producing, at less expense, the desired effect.

Rational as these different measures may be, I consider them powerless so long as the drinker of alcohol can find everywhere, at every hour and every step, a shop for the sale of his favorite beverage. To suppose them efficacious in the present state of affairs—that is, with unlimited liberty to every one to open a shop—is to expect on the part of the drinker, and especially for one to whom life is a hard trial, a moral constraint and an effort of reason of which he is incapable, at least in many mediums and under many social conditions. For this reason, without discrediting the results which may be reached by adjustment of taxation, I am still convinced that the surest means of restraining the drinker swiftly descending into alcoholism, and of preventing the fall of those as yet unacquainted with the mischievous seductions of the infirmity, is, first of all, to protect him against the temptation; then, if the measures which I shall call prophylactic fail, to inflict a punishment upon him proportionate to the gravity of his offense; and I am obliged to acknowledge with regret that nothing serious has been as yet done in France in either of these directions. Norwegian legislation, on the contrary, appears to me to be admirably conceived from the point of view of prophylactics. In Norway, whoever wishes to open a liquor shop must ask permission from the municipality, which may refuse it. In order to take away all retroactive effect, they had, in the beginning, to exempt dealers already established from the necessity of obtaining a permit; but when the successive extinctions did not diminish the number of shops fast enough, the municipalities were authorized to expropriate, on condition of indemnifying them, a suitable number of the existing shops.

This is evidently a measure which might give salutary results in every country, provided the municipalities are sufficiently im-

pressed with the importance of the object sought, and comprehend that it is nothing less than to save the country from a serious peril.

A priori, we might hope much from the Gothenburg system, which consists chiefly in intrusting the management of the public houses to temperance men, who, in selling alcoholic drinks, the use of which it is very hard to suppress completely in northern countries, and giving them to consumers only in proportions compatible with the maintenance of health, should make every endeavor especially to induce their customers to prefer tea and coffee. But I do not know whether this system has been greatly extended or has been generalized, with good results. I believe, however, that the most radical measure, and the one that has been most efficacious, is that of giving to municipal councils the right of absolutely prohibiting the sale of spirituous liquors. Where this system is in operation we may sometimes go considerable distances, it is said, without finding a single liquor shop. If a less restrictive rule is adopted, the prohibition of the sale on religious holidays, and before eight o'clock in the morning and after six in the evening on working days, can not but contribute to the success of a campaign like that so intelligently undertaken and energetically conducted by Norway. Whatever part may have been contributed by each of these measures to the realized results, it is a fact testifying eloquently to their efficiency that in that country the consumption of alcohol, which was in 1843 eight litres per inhabitant, has fallen to 1·70 litre, while in France it is now four litres, having risen, since 1850, from only 1·45 litre. In Germany the taxes on liquors are light, although they have recently been quadrupled; but increase of taxes has not brought about any reduction in consumption, which is 4·5 litres per inhabitant. On the other hand, it should not be forgotten that no serious effort has been made there until recently to contend against the scourge. It is announced, however, that the Government, struck with the dangers threatening the people by the increase of alcoholism, is preparing new legislation which will apply to sellers and consumers. For dealers it requires a license which will be granted only when competent authorities are satisfied of the need of the shop, or are given incontestable moral guarantees; prohibits their selling on credit, declaring all debts contracted for liquors null; forbids sales to children less than thirteen years old and to intoxicated persons; and makes them responsible for disorders occurring in their establishments, with penalties consisting of fines or imprisonment for not more than four weeks.

The new system affects consumers through the measures it provides for the protection of society and families against injury from drunkards. The principal of these measures are, besides the

pecuniary punishment for the public scandal of a man in a state of intoxication, removal to a special establishment for victims of alcoholism, and putting the drunkard under guard if he shows himself unfit to manage his affairs, or misbehaves in a way to imperil the safety of third persons. While the dealers do not accept with good grace a measure which will so greatly compromise their interests, and are petitioning against it, the women see in it a hope for the salvation of their families, and are also circulating petitions in which it is declared that when the free use of alcoholic drinks, often adulterated, is energetically prevented, prosperity will return to the homes of numerous workmen. The women are right this time, and I would sign their petition with both hands; and I wish that our French women might form a league for the same purpose, which might perhaps awaken our legislators from their indifference.

Austria has increased the tax on intoxicating drinks, and has endeavored to limit the number of public houses; but I have no documents at hand from which I can learn the effect of these measures. Belgium has not adopted any restrictive law except one against intoxication, and the consumption of liquors there has risen to twelve litres per inhabitant, while public houses have multiplied till there is now an average of one for every forty-three inhabitants, and in some places one for every twenty-four, or for every five or six adults. In the grand duchy of Luxemburg the number of drinking shops has become so excessive that a law has been promulgated raising the license fees and subjecting dealers to a tax proportioned to the number of inhabitants, with a proviso for considering the debts of the concern in fixing the fees.

Coming now to the Netherlands, I am glad to be able to recognize the wise enactments which your legislators have given you. They have thought, without doubt, and with strong reasons, in my opinion, that all fiscal measures would be ineffective so long as anybody or everybody should be at liberty to offer these mischievous drinks to the public. They have, therefore, prudently prohibited the combination of the trade in drink with a wholly different trade; and I appreciate this feature all the more because I see in France every trade, whatever be its nature, serving as a pretext for the sale of liquor, so that every person entering a shop, without thinking of harm, to buy food or any other goods, is exposed to the temptation of drinking alcohol, which he finds displayed before him. I am not, however, completely informed concerning the value of the results which this plan has brought forth. I have no data for comparing the statistics of the time before the measure was adopted and those following it, and the only statistics I have relate to the proportion of the victims of

alcohol per hundred of insane; from these it appears that after suffering a slight diminution on the application of the law, the proportion rose between 1878 and 1882.

From this summary I find that of the measures so far adopted against alcoholism those have produced the most important results which, taking account of human weakness and of the hardships of the struggle for existence in certain classes, have aimed to remove from the man the occasion for falling, in the adoption of which Norway leads among European states.

The repression which appears to me to be indispensable has so far played only a very secondary part; but I acknowledge that the German project presents a collection of repressive measures which may be of real efficiency.

If I could venture to formulate a few principles as the basis of legislation against alcoholism, I should propose: aiming at the dealers by limiting their number to a *pro rata* of the normal needs of the population; raising the license fee to the highest possible amount; giving license, as the German plan contemplates, only to persons of known morality; imposing on them, by a system of inspections and frequent analyses of their stock, the obligation to sell only completely rectified spirits; prohibiting their selling on credit, and declaring drink debts null; forbidding their selling to youths of less than twenty years of age; making them responsible for all mischief committed by persons coming from their establishments; and absolutely refusing license to all commercial establishments other than those especially devoted to the sale of liquors.

If we add to this an increase of the taxes on alcohol large enough to make the price of a glass too high for the man's purse, complemented with a reduction of the taxes on natural wines, tea, coffee, and sugar; supplementing this with frequent lectures on the benefits of sobriety and the anatomical injuries and physiological disorders produced by alcohol; and especially if we endeavor to preserve the rising generation from promiscuous associations and the corruption of the great centers, and instill into their hearts from infancy the principles of sound morals; and if the repressive laws against intoxication are rigorously executed the penalties against it are faithfully inflicted, and the protection of children against demoralization and abuse by unworthy parents which I have had introduced into our laws is guarded, we may perhaps see the rising wave of alcoholism recede.

This is the course, in my opinion, upon which those governments which, having assured the grandeur of their countries, perceive how it is threatened by alcoholism and how urgent is the necessity of arresting the progress of the vice, should now resolutely enter.

I do not know all the obstacles that may interfere in different countries against the efforts of the state to remove the danger. I know that in France and Germany the good intentions of the Government and Chambers will be strongly opposed by the innkeepers; but I know, too, that no obstacles are insurmountable to a political power strongly impenetrated with love of its country. —*Translated for The Popular Science Monthly from the Revue Scientifique.*

THE PAST AND FUTURE OF ALUMINUM.

By M. J. FLEURY.

AT the Universal Exposition of 1855 appeared for the first time an ingot of that silver-white metal from clay, as Sir Henry Roscoe called it. Aluminum does not seem to have attracted much attention from the public at that time. When it was exhibited again at London in 1862 and at Paris in 1867, in the shape of utensils of every sort, and jewelry, it had at first a success of curiosity, provoked by its extraordinary lightness of weight. But the difficulty of its manufacture and the consequent high price at which it was held, the delicacy of its color so easily soiled, caused it to be gradually abandoned in some of the arts, for which it was at first thought a new resource had been discovered. Its alloy with copper, aluminum bronze, notwithstanding its remarkable qualities of resistance and its beautiful golden color, hardly kept its place in industrial practice. Perhaps aluminum would have passed out of mention, except in laboratories, where its place is always marked, if its early history had not been associated with that of the progress of electricity, and if, by the aid of this new agent, its manufacture had not become so easy and so economical as to permit a considerable extension of its applications, and to provoke a revival of the hopes which had welcomed its beginning. These hopes are reasonable and are founded on the solid basis of the most serious scientific considerations. We have a right to expect much from this metal, an extensive use of it, and its substitution in many cases for others now at our service, provided it can be furnished at a price corresponding with that of other materials known in the arts.

Whether it presents itself in the earth of colors varying from yellow to brown, of which our fields are composed; or showing itself pure white, as in kaolin, clay is nothing else than a combination of alumina, silica, water, and other foreign bodies in varying proportions. Of this abundant earth, which forms approximately about half of the crust of the globe, the mass is about equally divided between silica the substance of rock crystal, and alumina;

and this, in turn with its earthy appearance, is oxide of aluminum. This metal, therefore, constitutes nearly a sixth part of the soil on which we spend our lives. The most abundant of all the metals, it is at the same time the one that is nearest to us. Thus alumina, and consequently aluminum, is literally under our feet—clay, of which it is the principal component, being found nearly everywhere. Rarely, and scattered in the masses of the rocks, precious gems may be found—emeralds, amethysts, sapphires, rubies, and topazes—which are only alumina, nearly pure in corundum, but alloyed with a little magnesia or lime in spinel.

It was not till modern chemistry was born that it became possible to separate aluminum from its earth. Carbon, which had been the chief agent for isolating the known metals from oxygen, was not effective in separating the elements of alumina; and even the electrical process with which Sir Humphry Davy produced sodium and potassium failed here. A roundabout process was devised. Oersted converted the intractable oxides of aluminum and magnesium, also not yet conquered, into chlorides, and Woehler decomposed them with potassium, taking advantage of the superior affinity of that metal for chlorine. Applying potassium to chloride of aluminum in the crucible, he obtained metallic aluminum and chloride of potassium. It appeared as a grayish dust, with a few globules, the largest of which was not bigger than a pinhead. From this small quantity only an incomplete determination of the properties of the element could be made. A more exact description was reserved for Henri Sainte-Claire Deville, who repeated Woehler's experiment in 1854. For the rare, expensive, difficult, and somewhat dangerous potassium he substituted sodium, which he found a simple method of extracting from sea salt; and instead of clay, the use of which required a preliminary separation of the silica and the alumina, he employed hydrated alumina, known as bauxite, of which considerable beds were worked in France for the manufacture of alum. Under the direct action of chlorine, a mixture of bauxite and sea salt became a double chloride of sodium and aluminum. The addition to this mixture, at the melting point, of the proper quantity of sodium, caused a separation of the aluminum, which collected in the bottom of the crucible. By remelting, the metal was cleared of most of its impurities and greater cohesion was given to its molecules, so that it could be cast into ingots. All this involved great expense, and the investigation could not have been effectively continued had not Napoleon III come to the chemist's aid with some of the unlimited funds of which he had the control. The next year, June 18, 1855, Jean Baptiste Dumas presented to the Academy of Sciences the first ingot of aluminum made in an industrial shop.

Under more extensive manufacture the metal has been studied at ease, and its physical and chemical properties have been exactly determined. It is silver-white, but little changed by the air, which gives it a slightly bluish tinge—except when it contains iron. Its most striking quality, and one which makes it most suitable for a large number of industrial applications, is its lightness of weight. Its density varies from 2·56, when it is in a molten condition, to 2·71, when its particles have been consolidated by hammering, and its mean density may be put at about 2·60—that is, it weighs about two and a half times as much as water, while steel is nearly three times as heavy, and copper three and a half times, silver four times, and gold nearly eight times; so that four times as many articles can be made from a given weight of aluminum as from the same weight of silver. In many cases one metal may be substituted for the other without inconvenience. While not so hard as gold or silver, aluminum is equally malleable and ductile: it can be beaten into thin pellicles that a breath will blow away, with which objects can be aluminum-coated as they are gilded. It can be drawn into wires finer than a hair, and yet so firm and supple that they can be woven with silk. It is less fusible than zinc and more so than silver, and is easy, therefore, to cast and mold. Although very sonorous, it has not yet been successfully cast into bells, because the repeated strokes of the hammer make it hard and brittle; but the tuning forks made from it are satisfactory to musical artists. The sulphurets, which blacken silver so quickly, are without action on aluminum. Similarly insensible to organic secretions, it lends itself to the making of certain surgical apparatus. Ingenious tubes have been made from it which permit patients who have been operated upon for tracheotomy to breathe, and American dentists have utilized it in the construction of their modern apparatus. It is equally fitted for making into plate and kitchen utensils, for which its specific lightness makes its use convenient. Its conductibility for both heat and electricity authorizes us to predict a fine future for it. It is, it is true, an inferior conductor to gold and silver, about as good as copper, and twice as good as iron; hence an aluminum wire will carry twice as great a quantity of electricity in a given time as an iron wire; or, to carry an equal quantity the aluminum wire need be only half as large; and aluminum being only one third as heavy as iron, it will have to be only one sixth as heavy. These properties should, were the cost equalized, make aluminum vastly more available for telegraphic and other electric wires than iron. Furthermore, aluminum not being acted upon by the air, galvanization, which is necessary for the preservation of iron wire, could be dispensed with.

Aluminum is, however, inferior to iron and steel in tenacity,

the quality of resisting the forces of pulling, bending, and twisting, which tend to break the metal or separate its molecules. Equal volumes of aluminum and cast iron have about the same power of resistance to these actions. That of copper is not quite double, but that of wrought iron is more than three times, and that of steel about five times as great. For purposes, therefore, where this quality is demanded, aluminum offers no advantages; but there are numerous other uses in which the question of a greater or less resistance is of no interest; and the other qualities of aluminum—its ductility, conductibility, and lightness—may be dominant reasons for employing it. Its use has hitherto been limited by the consideration of cost.

This difficulty is fast passing away as improved processes are applied, and the use of aluminum has been greatly extended and diversified since Sainte-Claire Deville exhibited the first manufactured specimen. In 1856 it cost one hundred and eighty dollars a kilogramme; the next year Deville was able to prepare it at La Glacière under more favorable conditions, and the price fell to sixty dollars. A year afterward the factory was removed to Salindres, where fuel and bauxite were within convenient reach. The price gradually fell; cryolite, a new aluminum mineral, discovered in Greenland, was introduced, and the metal cost only eighteen dollars a kilogramme in 1883. The manufacture was undertaken at several places in England, with improved processes based on the method of Sainte-Claire Deville. Mr. Castner devised a method of producing sodium by which the cost of that metal was largely reduced, and the price of aluminum suffered another fall. Then Mr. C. Netto devised a direct process for producing sodium by exposing pulverized caustic soda to the action of incandescent charcoal, and the cost of aluminum fell to seven dollars a kilogramme.

The brightest promises for the future of aluminum are offered through the electrical processes. When the flame of the voltaic arc is turned upon a mixture of pulverized mineral and charcoal a fusion takes place, and the metal, relieved by dissociation, flows out fluid, limpid, and brilliant. So fine a result, however, can be obtained only under the most favorable conditions, to secure which, not always with certainty, great pains are required. An easier process is to turn the voltaic arc, not upon the pulverized mixture, but upon a bath of mineral substances which have been previously brought to a condition of igneous fusion, as is done in the Cowles electrical process. Complex phenomena are then produced, both calorific and chemical. Important factories have been established for obtaining by this process both pure aluminum and its alloys with other metals, particularly with iron and copper. By it the company at Pittsburg obtained almost

chemically pure aluminum from the crude bauxites and corundums of which considerable quantities have been discovered in the northern United States. The factory at Neuhausen utilizes a part of the falls of the Rhine at Schaffhausen for the propulsion of powerful turbines which directly work the dynamos whence electricity is obtained for the production of aluminum and its alloys. Important manufacturing centers have also been established in England and Germany, and there are some in France.

By these new methods, which are still susceptible of improvement, a considerable saving over the old purely chemical processes is gained in the treatment of the minerals. In either case the chief effective agent is heat, and it is utilized far more completely in the electrical furnaces than in the older furnaces, which were subject to many cooling influences. Not more than four hundred grammes of coal burned in the furnace of a steam engine driving a dynamo will produce electrical energy sufficient to isolate in a molten electrolyte one kilogramme of aluminum. More than twenty times as much would have been required in the old chemical process. By virtue of this better utilization of heat, with greater profection in the equipment and management of the shops, the price of aluminum has continued to decline, till it is now very near the point when the metal can be profitably applied to the fabrication of many articles.

The alloys of aluminum now occupy a high position in practical industry. Aluminum bronzes and platings, lighter and more tenacious and more resisting than copper, and conducting heat and electricity better, will take its place. The new shops are also working for the production of cast and malleable iron, and they are in request by smiths for refining cast iron and steel.

The metallurgy of iron is now an exact science as well as an industry. Informed by analysis of the exact composition of the elements that enter into the fusion-bed, and of the character of the products at each moment of the operation, the metallurgist can determine with accuracy what he must eliminate and what add to give his product the quality required for the use to which it is to be put. A few hundredths of alloy will decide what it shall be. A little chromium will render artillery projectiles proof against breaking; nickel increases the resisting power of sheathings. Introduced at the right time into the Bessemer converter or the Martin furnace, a small proportion of the alloy of iron and aluminum communicates to the melted metal a fluidity which facilitates the disengagement of the gases that would otherwise remain imprisoned in the metallic bath, producing blow-holes, and destroying homogeneity and resistance in large pieces.

New uses are constantly found for the pure metal; less employed in jewelry, it is more used in the modest ranks of plated

ware and kitchen vessels. In Germany it has been introduced experimentally into the equipment of soldiers. Its alloy with the rare metal titanium, while still light, is very hard and tough. Could not picks, bayonets, sabers, and mess plates, imposing lighter loads on foot-soldiers, be made of it? The Russian army tried horseshoes of aluminum, and the horses of the Finnish dragoons, on which the experiment was made, are said to have gained perceptibly in speed by it. It has been introduced into machines, to reduce the dead weight—a gain of special value for aërial navigation and for cyclers. A canoe entirely of aluminum, hull and machinery, has been launched on the lake of Geneva, and suggests a new resource for the bold explorers of rivers with numerous rapids in Africa and elsewhere. Its application to aërostats is talked of.

The supposition is consistent with past experiences that new wants will arise as the means of satisfying them increase, and that the new metal, without infringing upon the domains of its predecessors, will in some way create the uses for which it will be employed. A salient fact in the history of the aluminum industry is the rigorously scientific character of the progressive steps in the discovery and production of the metal. Nothing has come about by chance, but all is the work of human intelligence. —*Translated for The Popular Science Monthly from the Revue des Deux Mondes.*

ELISÉE RECLUS AND HIS OPINIONS.

By Miss HELEN ZIMMERN,
EDITOR OF THE FLORENCE GAZETTE.

It is strange how sometimes two men distinctly different seem to reside in the same person. Who would believe it at first sight that Elisée Reclus, the eminent geographer, the careful, accurate, and scientific writer, should also be an anarchist of the most pronounced and uncompromising type—the man who actually regards Ravochal, the perpetrator of the outrage last winter at the Café Very at Paris, as a great man who died for his principles without betraying his friends? This great, large-brained enthusiast and kindly human being has unfortunately got this bee in his bonnet, a moral twist, that hinders him from seeing that the wrongs of mankind can not be righted by laws or lawlessness, but are inherent in the very constitution of our globe and of our imperfect organization. In a perfect world, with perfect inhabitants, a perfect society, perfect conditions would follow as a necessary corollary. But when a great man goes astray it is always interesting to try and discern the why and wherefore. It is on this account that in this article we deal rather with Reclus

the theorician than Reclus the eminent geographer, whose fascinating books on geography have vivified a science too often presented in dull and lifeless shape before the world. As great a geographer as Humboldt, he surpasses him in the fact that, like all Frenchmen, and unlike most Germans (and Humboldt was no exception), he is a fine stylist. His eloquent, graceful periods make even dry dissertations pleasant reading. Had he not held such extreme opinions he might have attained even greater fame, if this be possible. In any case we might have had more scientific books from his pen had he not given so much time to writing and speaking on his hobby. As this hobby reveals the man, may we expose it in these pages, without, however, on that account committing ourselves to any idea that we share them or wish to commend them to our readers. But a psychological study is always worth making, especially when the subject is so eminent and world-known. Before laying before our readers Reclus's mature opinions, let us cast a glance over his past.

Elisée Reclus is the son of a French Protestant minister, one of twelve children, of whom several have distinguished themselves in various departments. With a father so overweighted with an enormous progeny it is obvious that Reclus early made acquaintance with the pinch of poverty, for to maintain such a family in luxury would drain even the resources of purses deeper than those of French Protestant pastors. Elisée was educated in Rhenish Prussia, and his university studies were made at Berlin. It was no doubt in that city that he became inoculated with revolutionary ideas, for his student life fell in the time of ferment that preceded the uprising of 1848. Owing to his extreme democratic opinions, he left France after the *coup d'état* of December 2, 1851, and for several years traveled through Europe and America. It was on his return from these that he first wrote for the Revue des Deux Mondes and other periodicals the account of his journeys and geographical researches, which at once placed him in the forefront of all living geographers. But side by side with these geographical studies he continued to take an interest in social politics. It was he who was the first to point out in France the rights and wrongs of the American war of secession. It was he who helped to enlighten French public opinion concerning the cause defended by Lincoln. In consequence, the minister of the United States in Paris proposed that, as an acknowledgment of the great services rendered by Reclus, a considerable sum of money should be presented to him. This money the young learned man indignantly refused, although at the time he was in great pecuniary straits. He stated that he wrote entirely that right and liberty might triumph, and not for pecuniary personal recompense. Soon after this he published his magnificent

work on physical geography, entitled La Terre; and about the same time, to mark his disapproval of the despotism of the empire, he enrolled himself in the ranks of the International. During the siege of Paris he assisted M. Nardar, the well-known aëronaut, in sending communications out of the city, and also fought bravely in the National Guard. When the insurrection of March 18, 1871, broke out, Reclus, after publishing an eloquent appeal to his countrymen in favor of conciliation, flung in his lot with the Commune, and was taken prisoner by the Versailles troops. He was sentenced to transportation for life, after having been retained prisoner for seven months at Brest, where he occupied himself with giving lessons in algebra and mathematics to his fellow-prisoners. Meantime, however, the scientific world of Europe was roused to indignation at the condemnation to perpetual exile of so eminent a man; and when peace was once more restored in France, a number of eminent men, among whom figured the names of Darwin, Wallace, Lord Amberley, and others, sent in a petition to the head of the French Government, begging him to consider that in sentencing so eminent a man to transportation for life he was depriving science of great and incalculable services. Their petition was listened to, and M. Thiers commuted the sentence of transportation into one of banishment. Reclus in consequence went to live in Italy, where he resumed his labors, and where after a short time he had the sorrow to lose his young wife, whom he ardently adored, and who had shared his exile. After this he resided for a time in Switzerland, on the shores of Lake Geneva, working alternately at his geographical and communistic studies. He refused to return to France before all the prisoners of the Commune should have been amnestied, an amnesty was not granted till 1879. Thus it will be seen that his scientific labors and his humanitarian endeavors have ever gone hand in hand, nor is it so very long since he returned to France. Scarcely had he come back than he gained for himself fresh notoriety as the frank initiator of the anti-marriage movement.

He lives in Paris in the greatest retirement, and is in his person a very modest and refined man who hates notoriety above all things, and dislikes even the idea of being spoken of in a newspaper or a review; and nevertheless he is perpetually acting and writing in a manner that must necessarily draw public attention to him. He is a friend in heart and idea of Prince Kropotkine, the celebrated Russian anarchist, and he too styles himself an anarchist in the true sense of the word as he would explain it —that is to say, not the man who blows up houses and murders innocent women and children, but one who wants to change society and objects to every form of government; who has no feeling for country or patriotism, but only for humanity. Prac-

tically Reclus never meddles with politics, he cares only for social questions—outside, of course, the range of his geographical work. He holds that the Revolution of 1789 destroyed the privileges of the nobles, but that humanity has not advanced at all, nevertheless, because the *bourgeoisie* has disadvantageously taken the place of the aristocracy and usurped their privileges; hence, that the people are rather more unfortunate than formerly, because they know now that they are so. He considers that the state of society in which there are only what he calls "*les satisfaits*" and "*les misérables*" is a most abominable state of things, and he and his friend ardently hope that their doctrines will prevail sooner or later and change the face of things entirely. From every point of view Reclus is a most sincere, good, and excellent man, who would not hurt a worm, but would not budge an inch from his opinions. He has two daughters, and, as he considers marriage a bondage, he has united them himself to the men they loved. They were married by him in his own fashion, without any religious or civil ceremony, in the presence of witnesses. They have children who bear the father's name, as they also bear it themselves, but it does not appear that any steps have been taken to legitimize these children according to the laws of the state. Rumor has it—but for the accuracy of this rumor we can not vouch—that Reclus has had to suffer for his departure from the recognized social forms, for it is said that recently one of these illegal husbands abandoned the wife thus given to him.

In order that his ideas may be spread among the masses, for whose instruction they are primarily intended, Reclus has written a little pamphlet, which is included in the publications of La Révolte, a weekly communist anarchical organ published in Paris. Among the contributors to this series we find Louise Michel and the German Most, whose pamphlet bears the uncompromising title The Plague of Religion. If Reclus, who is now no longer young, and who less and less likes to be disturbed in his life of retirement, is asked to explain his ideas on social subjects, he has of late invariably referred his interlocutors to this little booklet, saying that if any one would know exactly what he thinks about the present state of things, and what he hopes for in the future, they must read what he has written there, and also read the contribution to the same series of his friend Prince Kropotkine, for he entirely shares his views. Evolution and Revolution is the title of Reclus's pamphlet; Anarchic Morality, that of Prince Kropotkine. The price of these small pamphlets is ten centimes. They are bound in a glaring pink cover and printed on villainous and utterly abominable paper, making us feel that, if this be a specimen of the æsthetics of the future, we rejoice to think that that future will not be ours. The matter is in both cases, fortu-

nately, greatly superior to appearances. Though we may differ a whole sky's breadth from each of the writers, we can but acknowledge the ability displayed by both. Reclus writes in a style so pure, so limpid, so exquisite, that we find ourselves reading on and on for the mere pleasure of reading, almost without pausing to analyze the meaning of what we read. Prince Kropotkine's way of writing, on the contrary, is bold, almost rough, sharp, and incisive, extremely well calculated to impress his meaning on the memory of his readers. Both works are the very reverse of reassuring in their tendency. Reclus's fundamental idea is that "evolution and revolution are by no means contradictory terms; in fact, that the first includes the second as a greater includes the less." "Evolution," he says, "the symbol of gradual and continued development in custom and ideas, is ever represented as if it were the contrary of that terrible thing revolution, which implies change of a more or less brusque description. Men discuss the history of evolution, the history of the gradual development of feeling and intelligence in the depths of cerebral cells, with apparent and perhaps even sincere enthusiasm. But woe if some one mention to them the abominable theme of revolution, which issues out from the depths of thought into the street, accompanied by the roar of crowds and the crash of arms! But evolution implies revolution, because those classes of society which possess the advantages which revolution is calculated to destroy oppose themselves to the peaceful march of evolution, and thus are the cause of those same violent movements which they deplore." In melodious tropes Reclus describes these phenomena. Both evolution and revolution, he says, have two faces, one benignant and one harmful. Religions, which from his point of view are most undesirable plagues, invented to keep the human mind in bondage, are but springs ever welling up afresh from the relics of the past. Thus, Christianity uprose from the relics of paganism. The American and French Revolutions were the moments in history when at last the rights of man were proclaimed, but their utterance proved barren, for a new privileged class established itself on the ruins of the old. "It may be said that until now no revolution has been absolutely spontaneous, and therefore none has been completely successful. All the great movements that have occurred up to the present, without exception, have been more or less directed, and have in consequence only been successful for the man or class directing; hence each has had its morrow of reaction. Now, however, the effects of social science are recognized by all, and the study of social movements must lead to the logical and instructive progress of the human race." How a revolution undirected is to succeed does not appear. "We can only arrive at social peace," says Reclus, "by

a profound study of the laws of history. The chessboard is before us—we have but to win the game." In eloquent pages he then sets forth the objects of the great general revolution he longs for. Religion, war, and marriage are denounced in fervent terms; even universities and engineers come in for the general denunciation. Some one must suffer in such a general disturbance—let it be the rich, say some agitators; not so, says Reclus, there must be no suffering class. There will come a day when wisdom shall be stronger than power, but to this end all bonds must disappear, and patriotism among the rest. He points out in one passage how the present French revolution has but assumed the arms and the ways of the Government it succeeded, and is a despotism in all but in name. Anarchy, the human ideal, can never come from the republic, which is a form of government. Science itself has become the ally of power: witness anthropometry, which he holds is turning the whole of France into a prison. Hereupon follows a tirade in praise of the International, with allusions to the eight-hour movement and the 1st of May. "So the great days approach; evolution is finished, revolution will not lag far behind. Is it not accomplished from day to day before our eyes? The time will come when evolution and revolution will succeed each other, when we shall pass from desire to action, from the idea to the realization; it is thus that life works in a healthy organization, be it man or the world."

Thus far the thinker Reclus leads us, leaving us at last with this oracular prediction. The frank, outspoken sentences of Prince Kropotkine have a less melodious but more powerful and awakening ring: "Why should I be moral?" he asks. "Why is one line of conduct good and another bad? All the motives which were placed before us in the past have gone away." He is as iconoclastic as his companion—nay, more so. None of the old rules have any force for him, yet even for him there exists a right and a wrong—the right and wrong of the hive and of the anthill, in which he sees the only fundamental rule of right and wrong; in this not differing at all from Christian thinkers, who also hold that that which is good for the human race, which in effect produces or permits the human creature to obtain the largest amount of pleasure and to submit to the smallest amount of pain, is good, while its reverse is bad. Very paradoxical is this Russian prince. Thus, he maintains that in some forms of society even cannibalism is a virtue, especially the devouring of the aged and infirm. He is decidedly unjust to Christianity, which enjoins the doing to others as we would they should do unto us, crediting that system only with an order to abstain from doing to others that which we do not desire should be done to us. It seems as if he really anticipated with desire

and appreciation a state of social existence resembling that of the bees and the ants, though how this is to be reached through the entire and unchecked development of every human creature, no matter what his propensities or passions may happen to be, he does not explain. We will not be governed, he cries; but should this not also mean we have no wish to govern? Like Elisée Reclus, he aspires toward the so-called perfect state of society—the state of things, as painted by them, which the unillumined intellect can but look upon as most outrageously and abominably dull, not to say tyrannical. Where in their human anthill or hive would be the place for such distinguished and brilliant intelligence as their own? Not even by the help of Richter's delicious skit, The Social Democratic Future, can one realize what a society founded upon absolute equality would become. Equality, says Prince Kropotkine, is equity; but he forgets that his models, the bees, destroy one class of their number, and that the ants are as warlike as the Zulus. In the model society of Reclus and Kropotkine the person who has the largest number of moral habits is the superior, if one may use such a word when the fact is no longer supposed to exist. They hold that the immensely large proportion of humanity, if left uncontrolled, would act in a manner useful to their fellow-creatures. It is only the fatal effects of war and religion which have warped them from this tendency. This wonderful faith in the ultimate goodness of humanity is exceedingly touching. Both Reclus and Kropotkine would be willing to risk trying the experiment of removing all restraint from the actions of mankind, and it is this perverted, childlike faith that makes such good men dangerous to society as at present constituted. Leave men entirely free, they say; fear not their passions. In a society entirely free they offer no danger; yet in the same breath they say: "Defend your own liberty, do not let yourselves be enslaved. Oppose your social passion to the antisocial passion of your antagonist. The great causes of deprivation—capitalism, religion, law, government—must cease to exist. The source of morality is the conviction of one's own strength. Life can only exist on condition of spreading and growing. Be strong; overflow with passionate and intellectual energy, and you will shed over others your intellect, your love, your power of action. Behold to what all moral teaching is reduced when freed from the hypocrisies of Oriental asceticism!" "Fallen cherub to be weak is miserable," says Milton's Satan. "Every one," says Kropotkine, "has his ideal, and to act in disaccord with this ideal is to be wretched. Make the good of humanity your ideal, and morality follows as a matter of course." Such are the ideals of these studious dreamers—a dreamer's ideals, and realizable only in a dream.

CORRESPONDENCE.

IMMATERIAL SCIENCE.

Editor Popular Science Monthly:

THE criticism made by Mr. E. S. Moser, in his article in the November Monthly, is undoubtedly sound from the writer's point of view, which is that of physical science. And yet there are many persons—for one, the writer of this letter—who, while recognizing the untenableness from the scientific standpoint of the positions taken in Prof. Lusk's article, yet as to the main idea accept it as true. When Mr. Moser asks, What is the spirit? he well knows that no answer can be given in the terms of science. Nevertheless, the one who is put to silence by the question may have certitude of the reality of man's spiritual nature.

It seems to the writer that the plain issue which is raised in this ever-recurring discussion of the natural *versus* the spiritual is whether man possesses faculties higher than the rational faculties, by which he can have conviction of truth that can not be reached by deductive reasoning. That there is no inherent absurdity in this idea is evident on the principle of evolution. In the history of the animal kingdom there was a time when sentiency was the highest form of mentality manifested by animals. From animals of this grade were evolved others of a higher grade, possessing not only sentiency but also rationality. Why should there not be a further evolution, giving rise to another set of faculties, higher than the rational faculties? Through the exercise of these higher faculties man may have certitude of truth which the rational faculties alone are incapable of attaining.

May we not say that the faculties which are exercised in the acts of prayer and praise to a Supreme Being are such higher faculties? In the ideal human mind—one in which all the normal faculties have proportionate development—would there not be such higher faculties? Who has not experienced moments when it seemed natural to pray to God, and others when it seemed natural to praise him? And by the exercise of these higher faculties is there not attained a certitude of truths which belong to a higher realm than the truths about material Nature?

Let any one who thinks he must give a negative answer to these questions before making a final decision go back in thought to that stage in the evolution of his animal ancestors when first a rational nature was being added to the powers of sentiency. How long may not the animals of that stage have hesitated to be guided by the dawning light of reason? how long doubtful of the truths which the exercise of their newly received faculties revealed to them? JAMES H. STOLLER.

UNION COLLEGE, SCHENECTADY, N. Y., *October 29*, 1893.

TAMABILITY OF BIRDS.

Editor Popular Science Monthly:

SIR: The article in The Popular Science Monthly for November—Birds' Judgments of Men—was one that was full of interest for me by reason of the matter contained in the article itself, and also because it recalled some of my own experiences with our little feathered friends.

Situated, like the house of M. Cunisset-Carnot, on the outskirts of the city, the one in which I spent the summer at the time in question was surrounded by trees of various kinds. Here the robin, bluebird, finch, oriole, and the sparrow, among others, came and built their nests season after season without fear or molestation.

Without doubt the kindness that was uniformly shown them and the care with which all avoided disturbing their nests prepared the way for the more familiar intercourse I succeeded in holding afterward with these cheery little tenants of our woods and fields.

One of the first methods I adopted for this purpose was to place a number of shelves in the trees, keeping them always supplied with foods, taking care as well that it should be done under their observation. This was easily performed, as they soon learned to note any movements on my part with this object in view.

My first advances were made toward the English sparrow, that Anglo-Saxon of our smaller birds. Always on the lookout to discover and recognize anything that may be of profit to himself, he is also the first to take advantage of it, to the exclusion of his less fearless companions. I taught them to know my whistle, to come at my call, and to eat the crumbs I dropped from my hand. Then I succeeded in having them take their food from the palm of my outstretched hand. At last, whatever doubt I might have felt as to their confidence in my good intentions was wholly dissipated by seeing them bring their young to me. These showed no signs of fear. On the contrary, they appeared to be as unconcerned about me as the parent birds that were feeding them at my feet.

They were always on the alert for their breakfast, flying from different quarters to my windows when I pushed back the blinds at rising. If for any cause they remained closed beyond the usual hour, the presence

of my little feathered pensioners was made quite evident by the hail-like pattering of their feet upon the tinned roof just below, where they hopped impatiently to and fro waiting for their matutinal repast.

The English sparrow, by reason of his domestic habits and acquired capability of adapting himself to the manifold and varying circumstances of our city and country life, has become one of the most knowing and observing of all our birds. But once a change in my clothing puzzled them. They knew my call, but the different color of my new garments seemed to have changed my personality. They would fly to me at my call, flutter about my head, hover over the food in my hand, and then, perching near by, would proceed to look me over and over with the most perplexed and serious air to fathom the mystery. After a while I established my identity and our old confidence was renewed. Indeed, it had become so complete that I now felt myself under a species of obligation never to disappoint them in their expectation of food, as they were on the watch for me whenever I appeared.

With the other birds my success was not so complete. But this was only what was to be expected. My attention had been mostly directed to the sparrow; the summer was drawing to a close, and they were seeking more congenial haunts. All, however, had become more familiar, for they seemed to have recognized my good will, and so much so that I feel assured that with the proper patience and favorable surroundings we can enter into very close and cordial relations with many of these little joyous minstrels whose beauty, song, and winged grace have brightened some hours in most of our lives.

Referring again to the English sparrow, it may be interesting to observe that I have seen him follow the robin about and snatch from his bill the worms as he pulled them out of the ground. Why the latter did not resent such audacious robbery I can not fancy, unless he knew that "discretion was the better part of valor"—that any attempt upon his part to chastise such a questionable messmate might bring down upon himself a mob of his companions.

His influence is already perceived in our streets, from which the once familiar pigeon is disappearing, as are many of our songsters from the field and garden, due also to his omnipresence. There is very little, if any, poetry or song in his life. His chief purpose seems to be "to possess the land," and to bring up as large a family as possible. Yet, while many have learned to regard him as a "wretched interloper," we can not but admire his hardihood, his intelligence, and his plastic instinct, by means of which he fits himself, like his human prototype, to the environments of the many regions he has invaded, and where, if the signs be true, he has come to stay and to exclude from their native haunts his more attractive and gracious rivals.

P. F. Schofield.

New York, *November* 18, 1893.

EDITOR'S TABLE.

PUBLIC OPINION.

There is nothing more tiresome than the platitudes in which popular orators and journals indulge when, generally for some sinister purpose, they set themselves to extol the wisdom and virtue of "the people." People who have any sense know just how wise and virtuous they are, and quite fail to see the point of the excessive adulation thus bestowed on them. It is difficult indeed to imagine what class of persons it is that can be gratified by praise of so inordinate and conventional a kind. Why should a lot of people who have chosen representatives of a certain kind care to be told that they are so very much wiser than the men they have chosen? yet that is the common refrain: the people are so much wiser and better than the politicians. If the people are so much wiser and better than the politicians, why don't they show their wisdom and goodness by bringing better men to the front? The men who are elected to-day may in a short time return to private life and become electors themselves: do they thereupon acquire a sudden increase in wisdom, and do they show their increased wisdom by helping at the first opportunity to elect worse men than themselves? That seems to be the way it is understood to work: the whole thing is fulsome and absurd to the last degree.

The truth, which, if it does not give

rise to this kind of talk, occasionally seems to afford a certain justification of it, is that, from time to time, "the people" defeat the expectations of the politicians by refusing to carry out the plans and arrangements which the latter have made; so that a "ticket" which, considering the party organization behind it, might have been supposed sure of victory, meets with ignominious defeat. It is much better to be wise sometimes than to be wise never; but it is not very satisfactory to reflect that an electorate which is capable of exercising wisdom and properly branding political immorality should require the stimulus or shock of some great scandal to bring its virtue to the front. The reason why politicians are encouraged to proceed every now and then to some unusual length in defiance of political principle is that, in general, they can reckon on the partisanship of their followers to support whatever they may propose. What the public have to do, therefore, when by a tardy or fitful exercise of political conscience they have escaped some disgrace, is not so much to congratulate themselves on a remarkable achievement as to wonder, with some little humiliation, why the achievement was necessary—why their political leaders ever came to propose to them anything so disgraceful. It is rare that a man is approached with a disgraceful proposition unless he has in some way created the impression that the proposition might be well received; and therefore, mixed with any lofty indignation with which he repels it, should be some heart-searching as to how the whole thing came about. Applying this to a case which is fresh in the recollection of all, how much of moral inertness, how much of blind partisanship, how much of indifference to higher considerations of national welfare must have been shown on many occasions by respectable voters, before the managers of a great party could venture to place on their ticket a name which the most elementary considerations of political or moral principle should have sufficed to exclude from it!

It is, of course, satisfactory to think that there are bounds which can not be passed—that there is a point at which the better sense of the community rebels—but it is impossible not to think at the same time that this better sense might be kept in more regular exercise. Instead of descending like a *deus ex machina* into the political arena on critical occasions to safeguard the state against some signal danger, why should it not be the daily providence and bulwark of the state? The modern state depends for its prosperity and security on the faithful performance by citizens of their political duties; and it therefore behoves every citizen to inform himself as to the issues of the day, to consider carefully which side he should take, looking to the greatest interest of the country, and to vote and otherwise shape his course accordingly. If this were done as a rule by all voters capable of forming an intelligent and honest judgment, there would be very little encouragement given to dishonest political machinations; and those elements in the country that count on political corruption in one form or another for liberty to pursue fraudulent and immoral ends would find their action so circumscribed that all the profits of their several nefarious trades would be gone. There is reason to hope, we are very glad to say, that the sounder elements in the community are becoming more conscious of their strength and more disposed to use it for the purification of politics. Not one recent election only, but many, have turned more or less on moral issues, and have turned in the right direction. Let there be no pause in the good work; above all, let there be no reaction. The effect upon the administration of the government in any country of a decided expression of public opinion in favor of what is right, rather than of what is expedient in a party sense, can not but be

beneficial. Does any one suppose that the public gets full value for the enormous expenditure incurred for the salaries of officials? If any one does, we venture to say that he is seriously in error. Neither the intelligence nor the zeal of public employees in general comes up to the standard that might be realized if our politics were dominated by higher principles; and not only is a vast burden thus laid on the industry of the country, but many advantages which might be secured to the public are lost. Let us make the most of any encouragement we have received; but let us not draw the lesson, either that the people at large are very wise and good, or that the forces of evil have been permanently discouraged. The people at large are good enough to do a great deal better than they generally do; that is about as much as can be said on that point. The forces of evil are hard to discourage and very hard to destroy. They watch their opportunity, and are as assiduous as the spider in repairing the party webs which an outraged public sentiment may have torn. Public opinion is something that should be invoked at all times against every form of evil, and every possible means should be used to keep it alive and active and watchful. The adulation so frequently bestowed upon "the people" is a moral narcotic rather than a stimulant, as it suggests that everything must go well in a country where there are such vast reservoirs of wisdom and virtue. The true note to strike is that of *responsibility*. An honest man does not require to be told he is honest; and a dishonest man is not made better by it. The message to each and all is, that we have public duties and responsibilities commensurate with the great advantages we derive from our membership in a civilized state, and that we can not neglect these without dishonor and loss.

INTERNATIONAL ARBITRATION.

It is greatly to the credit of the United States and Great Britain that they should now on several occasions have submitted disputes which might otherwise have given rise to war, to the decision of a court of arbitration, or, as in the case of the San Juan question, to that of an individual arbitrator. One conclusion that may be drawn from this course of procedure is that, as between these two countries at least, war is a discredited and obsolete method of settling disputes. The question now is why it should not soon become the same for all civilized nations. The burden of military taxation in Europe is becoming well-nigh intolerable. One or two countries, notably Italy, are now on the very verge of national bankruptcy, and all because the wit of man, at the close of the nineteenth century of what has been called the "Christian" era, can not devise any adequate means save war on a huge and most destructive scale for the adjustment of conflicting international claims. It seems impossible that the sin and shame of this should not before long become intolerable to all well-disposed men; and on the continent of Europe, not less than in England and the United States, the great majority of men may come under that designation. The time has arrived, we think, for a serious demonstration in favor of arbitration as a substitute for the barbarous method of the sword; and the duty of initiating such a movement would seem clearly to lie with the two nations who have themselves set the example of a successful and happy use of arbitration. The project of persuading the nations to turn their back on war is indeed a vast one, but that is no reason why it should not be taken in hand—why, in the first place, a rough sketch, as it were, of the conditions necessary for the realization of the object in view should not be made and taken into consideration. Of

course, if any one nation is cherishing schemes that are in their nature inconsistent with peace with its neighbors, that nation could not be counted on for any sincere co-operation; and therefore the first thing to do would be to invite from each nation as frank and full a statement as possible of its views and aspirations, in order that the extent to which these came into conflict with those of other nations might be determined. We can not resist the belief that, if the matter were taken in hand seriously, the British Government, as being more directly interested in the peace of Europe, taking the lead, and the Government of this country lending it all the moral support possible, a hopeful beginning might be made. The thing could not be done in a day; but, unless we have faith enough to believe in the possibility of its being done, how is it going to be done at all or at any time? War has lasted through nineteen centuries of the Christian era, and still exists as a horrible fact and still more dread possibility in the era of science. It has lasted too long. Christianity and science should unite their forces to crush it.

LITERARY NOTICES.

The Psychic Factors of Civilization. By Lester F. Ward. Boston: Ginn & Co. Pp. 369. Price, $2.

In this book Dr. Ward elaborates and reenforces the main plea of his Dynamic Sociology, published ten years ago. His central thought is that civilization owes its chief impulse to man's conscious effort to better his lot—an effort in which, so far from imitating the operations of Nature, man has modified or even reversed them. In this view, civilization for its further advance must look more and more to a control in the highest sense artificial, which shall aim solely at the public good, restraining all self-regarding activities in conflict therewith. The chapters before us embody the observations of an accomplished naturalist, and add original and brilliant illustrations to an argument somewhat familiar. Every skillfully drawn picture such as this, which limns the felicity awaiting mankind when self-love and social shall be the same, kindles the moral imagination, and in so far has distinct value. But whether the practical orchestration of human wills and motives, which Dr. Ward holds to be eminently feasible, is feasible, or even possible, may well be questioned. As time goes on, and the problems of life, political and social, grow in complexity, the task of bringing self-interest and the public weal into accord does not become easier, as multiplied failures abundantly attest. One of the reasons is that the democratic spirit which justly maintains the equality of rights is apt unjustly to ignore or resent the inequalities of talent and character which difference man from man. And only a hearty acknowledgment of these inequalities can yield the assured leadership and the loyal adhesion upon which social progress largely depends. Dr. Ward holds that with better social conditions character would be reformed. True. But how can there be that in the mass which is not in the atom? Our author is of the school which would have reform begin at the outermost circle of human life, the political, and thence pass to the core and center, the individual heart. In this kind of project there is an oblique and subtle flattery in that blame for individual woes and privations is laid solely at the door of "society," of institutions, of somebody or something outside the sufferer himself. Never by any chance do the painters of social Utopias show how wide is the home acre for improvement, how much neglected it is, albeit that its plow awaits no sanction from the lawmaker, and how the despised field for tilth which surrounds every man's door is just the place for him to gain the skill, the discipline, needful in planning and carrying out the large transformations which gild the dreams of socialistic prophecy. Dr. Ward enlarges, and without exaggeration, on the wastes and burdens of industrial competition. Experience in Great Britain amply proves that many of these wastes and burdens disappear on the simple organization of the co-operative store—an establishment in this country as rare as an observatory. Co-operation requires forbearance, steadfast-

ness, strict probity; shall men be expected to manifest these first of all with regard to a few things or to many things? Our author has a passing word for "natural monopolies," and deems it desirable that they be nationalized. In the current discussion of these monopolies land always figures as the chief, and the one way of escape from the ever-increasing exactions of the landlord is declared to lie in his being superseded by the Government. Of a different stamp from the people who harbor this doctrine are the two million families in this country who have slipped from beneath the landlord's yoke, through the undramatic agency of the building association. Homely and humdrum enough is the virtue of thrift, but thrift and its fellow virtues of industry and sobriety mean trustworthiness. With its birth, and only with its birth, can the attack upon the obstacles to social reconstruction take heart of hope. In its hands self-help holds opportunities which, were they exhausted, would not simply contract the area for centralized sway, but incidentally prepare men to establish that sway in so far as it may be gainfully done.

Dr. Ward is too careful an observer to miss as a trait of the American public its distrust of governmental interference with individual activity. That distrust has not been unaffected by recent events. The Silver Purchase Act was an attempt to overrule the individual impulses of the people in a way which was to create for them new and gratuitous blessings as a community. At the date of its repeal the act had involved the nation in a loss of at least $400,000,000. This sum, vast as it is, forms after all but a solitary item in the cost of that more ambitious overruling of all for a few which masquerades as protection. In socialistic or, to adopt Dr. Ward's term, sociocratic legislation there ever lurks the danger that the interest of a band of manufacturers, mine-owners, soldiers, or office-holders can be made to appear identical with that of all. Experience proves that legislators are apt to form a class apart, separated from the public in a fool's paradise of echo and subserviency, and with interests often opposed to those of the people whom they ostensibly represent. At Albany and Washington a minority of them cemented together by the pursuit of plunder have repeatedly defied a majority whenever that majority has lacked close regimentation.

Dr. Ward adduces examples of species which with swift pace have stridden ahead on the artificial withdrawal of competition; he fails to refer to cases more numerous still where the absence of competition has ended in the degeneracy which overtakes the parasite. In the author's own city of Washington attention last year was drawn, on the floor of Congress, to the waste of public money in the counting and recounting, the polishing and labeling the pebbles of science by officials in the borrowed garb of the geologist; and last spring Secretary Morton, in taking charge of the Department of Agriculture, found one of his first duties to be in setting adrift the barnacles which in four short years had fastened themselves upon a single, and not particularly inviting, ship of state.

Modern Meteorology. By Frank Waldo. Contemporary Science Series. New York: Charles Scribner's Sons. Pp. 460. Price, $1.25.

The chief aim of this treatise is, in the words of the author, "to bring the reader into closer contact with the work which has been and is actually engaging the attention of working meteorologists rather than to present finished results." More than a third of the volume is devoted to descriptions of meteorological instruments and the methods of using them, with some account of certain meteorological laboratories. The details of equipment and routine of the observatory at Pawlowsk, Russia, are given with much fullness, and the author states that he knows of no similar account of the regular work of an observatory. A number of views of observatory buildings and their surroundings are presented, including several mountain observatories in the United States and Europe. The work of German meteorologists is given large space in this treatise. Thus the chapter on Thermodynamics of the Atmosphere is mainly a presentation of the ideas of Prof. von Bezold, as set forth in his several memoirs recently communicated to the Berlin Academy of Sciences. There is also a history of the various theories of general and secondary atmospheric circulation.

This is followed by an account of the principal results of meteorological observations up to the present time, and the work closes with a section on the application of meteorology to agriculture. Besides the views already mentioned the volume is illustrated with a large number of diagrams, charts, and cuts of instruments.

Zoölogy of the Invertebrata. By Arthur E. Shipley. New York: Macmillan & Co. Pp. 458. Price, $6.25.

This is a text-book for college students who have some knowledge of biology, but is not intended as an advanced treatise. The author has undertaken to describe one example of each of the larger groups, with specified exceptions, and then to give a short account of the most interesting modifications presented by other members of the group. A great extension of our knowledge of the invertebrata has been made in the last few years, leading to a rearrangement of material and a revised classification. These facts have led the author to treat the subject largely from the morphological standpoint. More space has been devoted to animals intermediate between the larger groups than to the more specialized members of the groups. The text is illustrated with 263 cuts.

The Genesis of Art Form. By George Lansing Raymond. New York: G. P. Putnam's Sons. Pp. 311. Price, $2.25.

Gothic Architecture. By Edouard Corroyer. Edited by Walter Armstrong. New York: Macmillan & Co. Pp. 388. Price, $2.

The former of these two very suggestive and interesting works on subjects of art is described in the subtitle as "an essay in comparative æsthetics, showing the identity of the sources, methods, and effects of composition in music, poetry, painting, sculpture, and architecture." It is the result of an endeavor to trace to their sources in mind or matter the methods employed in the composition of the art forms; and as an incidental though seemingly necessary step to the accomplishment of this object the action of the mind in these methods has been identified with its action in scientific classification; and, having arranged them according to their logical order and development and added to them those methods hitherto recognized only indirectly or not at all, their character and effects are shown to be exemplified in all the arts, including music and poetry, etc., as well as in painting, sculpture, and architecture. It takes many centuries, the author says, "for such methods to develop into arts like those which have been named. But, after a while, these all appear. It is important to notice, too, that the way in which they differ from ordinary and merely natural modes of expression is the fact that they are not used, or, if so used at first, have ceased to be used for expression's sake alone. . . . While, therefore, the art-product is traceable to an expression of mental thoughts and feelings, the elements of which it is constructed are forms borrowed from Nature, and the method of construction, or composition as it is ordinarily called, is a process of elaboration." The theoretical has been so connected in the essay with the practical, as the author hopes, to adapt the work to the wants of readers who, while interested in one or other of these phases of the subject, are not interested in both; and the effort has been made to distinguish between well-grounded tastes and mere fashions or whims.

M. Corroyer's Gothic Architecture, translated from the French by Miss Florence Simmons under the editor's direction, is intended to give such an account of the birth and evolution of that form of the art as may be considered sufficient for a handbook. The author, writing from a thoroughly French point of view, is apt to believe that everything admirable in Gothic architecture had a Gallic origin. He dismisses vexed questions of priority with a phrase, and finds French influence in the examples which he cites traceable to suggestion from a French master or a French example. In this disposition he is very like nearly all other Frenchmen, in whatever field we take them—with a few shining exceptions like M. Taine, or, in the author's own field, M. Viollet-le-Duc, whom he sometimes contradicts. This characteristic weakness may, however, be discounted, and, when the allowance is made, does not greatly affect the value of the author's observations as a picture of Gothic development. Taking an evolutional view of the growth of Gothic architecture, he points out how material conditions and discov-

eries and their consequent social changes brought about one development after another in the forms and methods of the architect. Both of these books are liberally illustrated with engravings of the world's best works in the departments considered, or—when mistakes are presented as warnings—of some that are not so good.

Personal Recollections of Werner von Siemens. Translated by W. C. Coupland. New York: D. Appleton & Co. Pp. 406. Price, $5.

We have already given the readers of the Monthly a foretaste of this delightful book in the sketch of Dr. Siemens, published in the October number, the data for which were derived from it. The book affords abundant instances of racy incident and adventure, keen character sketches, and historical reminiscences. The author came to the task of composing his recollections with a hesitation he need not have felt, for all the care they called for to give them the living interest they possess was the simple telling of them just as they presented themselves. But he was desirous of being his own chronicler, in order to preclude the possibility of future misunderstanding and misrepresentation of his endeavors and actions, "and I have an idea also," he adds, "that it will be instructive and stimulating to the coming generation to be shown precisely how a young man, without inherited resources and influential supporters—nay, even without proper preliminary culture—may, solely through his own industry, rise and do something useful in the world. . . . I shall, however, at the same time try to indicate those inner and outer forces which have borne me through weal and woe to the desired goals, and which have made the evening of my life an easy and sunny one." All this we find in the book duly presented, with the result, probably, of making the work a more interesting one than if the author had been bound by restraints and conventionalities. As we read, we are shown the surroundings and conditions of his childhood and youth, the salient traits of his various instructors, his joys and mishaps at school, his first experiments, and the adventures to which they led him; his military and political experiences, his introduction to commercial and public life, the gradual development of his inventions and enterprises, and the impression they made upon the arts and industries of the world. The last is, of course, the important feature of the work, around which the other and minor incidents entwine themselves as the vine around the tree trunk. The more we regard his inventions the more we are struck with the importance of the part they fill, and the extent to which they cover the industrial development of the world during the last half century. They include experiments with electricity when that force was still new as a worker; electroplating, in which Siemens was a pioneer; some of the earliest efforts at electric-telegraph signaling; the building of the first telegraph lines in Germany; the carrying of the telegraph through the countries of northern Europe and into Asia; in connection with these, trials of the relative advantages of underground and overhead wires and experiments in insulation, all of which were then new; journeys, full of adventure, full of amusing and exciting if not often thrilling incident, in connection with his enterprises; the laying and working of the first electrical submarine batteries; tentative experiments in cable laying under water; the laying of the first submarine cables, and the laying of cables thousands of miles in length under all the oceans—in all of which Siemens had a great part; the beginnings of electric railroading; and numerous other inventions of greater or less importance. Then the men with whom Siemens had to do during his busy life are introduced to us; persons in royal station, statesmen, ambassadors, financiers, philosophers, and men of science—the latter classes including, at least in Germany, some of the brightest lights of the half century. Besides the references to them as they come up in the course of the narrative, a separate chapter or appendix is given to the account of the author's scientific writings, in which the particular points he wished to bring out in them are more fully indicated. This enables us to mention one which, though only a theory that no one has yet ventured to accept—while no one has successfully contradicted it—must ever be associated with Siemens's deepest scientific studies: his theory of the maintenance of the sun's heat and light.

As may be readily perceived, the Recol-

lections cover a considerable variety of subjects, the presentation of which might have been made very dry and uninteresting. Siemens, in his artless way of telling of them, makes them all as interesting as the story of his first heroic act—his discomfiture of the gander that threatened and frightened his sister. The facts are among the most important landmarks of the scientific advance of the times; the presentation of them gains immeasurably in value by being made attractive.

The Gilded Man (El Dorado), and Other Pictures of the Spanish Occupancy of America. By A. F. Bandelier. New York: D. Appleton & Co. Pp. 302. Price, $1.50.

Mr. Bandelier, one of the most painstaking and accurate of American archæologists, has in this volume presented the result of his researches in the history and dramatic incidents of the early gold-hunting expeditions of the Spaniards in Venezuela and Colombia and along the banks of the Amazon, and of the first invasions and early settlements of New Mexico. The book concerns two distinct scenes of adventure—the northern part of South America, and the Southwestern part of North America. On the stories of both Mr. Bandelier casts new and clear light. We do not know that the story of El Dorado has ever before been fully set forth and traced to its exact origin and foundation in fact in a book intended for popular use. It is so set forth in the first part of this book. With it is related the story of the expeditions of which this semi-mythical personage and his gold were the object; the foundation of the military and trading posts by hardly responsible adventurers on the coasts of Venezuela; the lease of Venezuela to the house of Welser & Co., of Augsburg; the condition and relations of the Indians of Bogotá, where El Dorado resided; the expedition of Dalfinger and the conquest of Bogotá by Ximenes de Quesada; his meeting on the plateau of Cundinamarca with his rival adventurers Benalcazar and Federmann, approaching the spot with the same object from different directions; the adventures of Georg von Speyer on the Meta, and of Philip von Hütten in search of Omagua; the tragic journey of Pedro de Ursua and Lope de Aguirre from Peru down the Amazon; and other expeditions of more or less significance, all marked by dangerous adventure and generally by disaster; and all prompted, in one way or another, by the vision of the Dorado, which the author likens to a mirage, "enticing, deceiving, and leading men to destruction." In the second part of the book, Mr. Bandelier does a like service for the myth of the seven cities of Cibola, which were the object of expeditions into New Mexico leading to the first settlements of that territory. To the determination of the location of Cibola he brings a considerable fund of linguistic knowledge and the fruits of industrious geographical and archæological exploration, and decides upon Zuñi as the chief of those cities. The story of the search for Cibola includes the relation of the marvelous adventure of Cabeza de Vaca, the missionary journey of Fray Marcos de Nizza, and the expedition of Coronado to Cibola, and thence, in search of Quivira, to the plains of central Kansas. Three additional chapters include an inquiry into the facts of the massacre of Cholula, inflicted by Cortes in 1519; the determination of the age of the city of Santa Fé, New Mexico; and the story of the later life of Jean l'Archévêque, the youthful accessory to the murder of La Salle, and of the fortunes of his family in New Mexico. These histories afford no end of exciting incidents and of themes on which romances and sensational stories might be founded; but Mr. Bandelier's object has not been romance or sensation, but the elucidation of the facts, the discovery of the real history. To this history his essays are a valuble contribution.

The Points of the Horse. A Familiar Treatise on Equine Conformation. By M. Horace Hayes. New York: Macmillan & Co. Pp. 379, with Plates. Price, $10.50.

The author of this book assumes that exact ideas on the subject of conformation are not current either in the traditions of people familiar with horses or in English literature. Both English authors and French have erred in trying to make general rules suitable to all kinds of horses, instead of pointing out that the standard of shape should to a great extent vary according to

the work demanded. Illustrations, moreover, of horses, or of special points of them, drawn without the aid of photography, are liable to be affected by the bias of the artist. In this book, photography, as far as practicable, is relied on for illustration. For further light on the respective points of speed and strength in the horse, the conformation of other animals that are distinguished by the possession of one or other of these gifts in a high state of perfection is examined. A more exhaustive inquiry is also made into the nature of the paces and of the leap of the horse than has previously been attempted; the object being to obtain from it exact deductions as to the best kind of conformation for various forms of work. The first principles of conformation having been laid down, descriptions are given of the structure of the body, the anatomy, the mechanism of breathing, the distribution of weight, the levers, the mechanism of locomotion and of draft, the attitudes and paces, the comparative shape, the trunk, the limbs, action, hardiness, and cleverness, condition and good looks, weight-carrying and staying power; blood, symmetry, and compensations, special points of various classes and various breeds of horses, wild horses, asses, the evolution of the horse, photographing horses, and proportions of the horse; concluding with criticisms of painters' horses. The book is furnished with a bibliography and an index, and is illustrated with seventy-seven plates, reproductions of photographs, and two hundred and five drawings.

In reading over the Rev. A. J. Church's book of *Stories from the Greek Comedians*, we are reminded again of the intense human-likeness that pervades all the Greek writings, which has given them their long life and makes them as fresh and readable as the day they were written. We should hardly anticipate finding in the little pieces of Aristophanes, written in the days of the Peleoponnesian war to make the Athenian populace laugh over the petty vices and follies of their fellow-citizens—and reflect, if they would, over their own course—character sketches that would fit as well to-day in New York or any other American city: exposures of tricks and devices to gain influence, wealth, and power, from which those now familiar among our own politicians and speculators might have been copied; views of similar "rings" and similar demagogues currying favor with the people in the same ways, and a similar populace binding itself in consideration of little bits of patronage and flattery to them; the "labor element" with its demands and threats and the leaders bowing to them. But these are all to be found in one or another of the nine comedies of Aristophanes; and he might as well have lived and written in New York or Chicago at the end of the nineteenth century as in Athens 2,300 years ago. His manner of presentation might be changed to suit modern fashions, but the substance and the essential features of the characters and situations would be the same. Besides Aristophanes, Philemon, Diphilus, Menander, and Apollodorus are represented in the book, having passed through the Latin versions of Plautus and Terence. Mr. Church does not give us the plays as such, but the kernel of them, in the form of stories, with parts of the dialogue. (Price, $1.)

The bulletin on *The Salt and Gypsum Industries of New York*, contributed to the New York State Museum by *F. J. H. Merrill*, Assistant State Geologist, is published in accordance with the law of 1892 relating to the appropriation for the geological map. Its purpose being not merely to publish such new information as can be gathered, but to give in concise form what has previously been made public, besides the author's own surveys, other authentic sources of information have been drawn upon. The account proper of the New York salt beds is preceded by general observations on the distribution and origin of salt, the composition of sea water, and the deposition of salt beds. Then are given the story of the development of the Onondaga salt field, the discovery of rock salt, the geology of the salt and gypsum, the altitude of the salt beds, well boring and tubing, the mining of rock salt, analyses; descriptions of the manufacture of salt in the State of New York by solar evaporation, direct fire evaporation, steam evaporation, and vacuum evaporation; with comparison of brines and processes, and statistics and facts. The account of the gypsum industry in New York, following the articles on salt, includes the descriptions of

gypsum quarries, statistics the annual production of gypsum, and an account of the uses of gypsum.

In *The Cosmic Ether and its Problems* that mysterious substance or agent is presented by Mr. *B. B. Lewis* as the invisible actuator of the world of ma'ter and life. Accepting the current theories of the ether the author elaborates them and applies them to the accounting for various cosmic and terrestrial phenomena more positively, perhaps, in some instances, than sober science is yet ready to assert, though we have not noticed that he transcends the bounds of some scientific speculations. The field of knowledge outlined in the essay seems to find a definite limit, the author says, only on the one hand in the direction of inquiry as to the nature and origin of the material molecule, and, on the other hand, "as to the separate entity and perpetuity of that ether inspiration constituting the sentient, intelligent personality actuating the physical life organism"—which will doubtless remain "permanently unanswerable to scientific methods of investigation." (Published by the author at Bridgeport, Conn.)

The same subject is treated in a very different manner by *Terence Duffy*, author and publisher, of San Francisco, in a ' ook entitled *From Darkness to Light*, wı. 's further defined as Duffy's Compendiums .f Nature's Laws, Forces, and Mind combined in one; conformable to this, his great discovery that the sun and earth are the poles of the magnet. "Explains the motion of the earth, how maintained, what space is, what force is," etc. The author has intended, he says, to write as he understands, and to be as concise as possible, in plain words without any elaboration. We can not tell whether he keeps within science or flies away l.,ond it. His statements, as they read, have an air of absurdity; yet when we take a passage, analyze it, and translatė it into ·al language, it appears that the author may mean well, after all. The book's only value is as a curiosity.

A study of *The Deadly and Minor Poisons of Toadstools* is published by Charles McIlvaine, of Haddonfield, N. J. By toadstools the author means visible fungi as distinguished from microscopic. To the alkaloid, or poisonous principle, he gives the name of amanitine, preferring it, as derived from the name of a family of plants, to muscarine, the usual name, which relates to a species. Its most certain and powerful antidote he finds to be atropine.

The *Eleventh Annual Report of the United States Geological Survey* contains the usual account by the director of the operations of the year, in which the value and efficiency of the several divisions are carefully pointed out, followed by administrative reports of the heads of divisions. Two papers are appended to the report of operations: the first is on The Pleistocene History of Northeastern Iowa, by W J M'Gee; and the second on the Natural Gas Field of Indiana, by Arthur John Phinney. Mr. M'Gee's paper is illustrated with forty plates and one hundred and twenty cuts and Mr. Phinney's with five plates. A second volume contains the second annual report of the director upon the Irrigation Survey. This embraces the results of the work of the divisions of hydrography, topography, and engineering for the year ending June 30, 1890, together with a detailed statement made by the director before a committee of the House of Representatives, discussing the problems of irrigation in the arid lands of the United States. It appears from the report that a great deal of work has been done in locating agricultural lands that are accessible to water, in gauging rivers and rainfall, and in surveying reservoir sites. The text is accompanied by sixty maps and views and four cuts of apparatus.

In *A Select Bibliography of Chemistry*, an attempt is made by *H. Carrington Bolton* to collect the titles of the principal books on chemistry published in Europe and America from the rise of the literature (1492) to the close of the year 1892. The term chemistry is taken in its fullest significance, and the bibliography contains books in every department of chemical literature, pure and applied. It is confined, however, to independent works and their translations, and does not include academic dissertations nor "reprints" and "separates," and no attempt has been made to index the voluminous chemical literature, except in the section of Biography. Full bibliographical details have been given where possible. A considerable number of the books have been personally examined,

and are distinguished by a mark signifying the fact; "and for these alone can the compiler be wholly responsible." To facilitate reference the work is divided into the several sections of Bibliography, Dictionaries, History, Biography, Chemistry, pure and applied, Alchemy, and Periodicals—the last section having been taken from Prof. Bolton's Catalogue of Technical and Scientific Periodicals. Notes and comments, bibliographical and explanatory, have been occasionally introduced to aid students in conceiving the character of a book or the status of its author. The Bibliography forms volume xxxvi of the Smithsonian Miscellaneous Collections.

Mr. *B. Douglas Howard*, in a book entitled *Life with Trans-Siberian Savages*, describes his visit to the Ainus of Sakhalin, whom he characterizes as "the most ancient, distant, and least known savages surviving in Asia." There has been very little communication between this island and the rest of the world, and there will hereafter be less, as the Russians have made it a penal colony and secluded it. Mr. Howard's relations of his observations sound more like those of a globe trotter than of a profound student, and his accounts differ in several respects from those given by other writers of the Ainus of Yezo. He represents them as plunged in the lowest savagery. He also visited the Ainus in Yezo, and found them little better. Yet he thinks that through the Ainus of Yezo, with whom an intercourse exists, we may learn to understand their more primitive brethren in Sakhalin. He further attempts to elucidate the Ainu religion. (Longmans, Green & Co., New York. Price, $1.75.)

Mr. *W. J. Johnston* has aimed, in the preparation of his *Elementary Treatise on Analytical Geometry*, at an easy and gradual development of the subject. The requirements of two classes of students have been kept in view: First, students in the university colleges, by whom a limited course of the subject is read, and for whom such a course is marked out; and, secondly, candidates for mathematical honors, for whom the chapters on Trilinears, Reciprocal Polars, and Projection are included. These chapters will also serve as an introduction to the writings of Dr. Salmon. Many other features are introduced, the usefulness of which will be perceived by the student. (Macmillan & Co.)

A work on *Heat*, prepared by *Mark R. Wright*, is intended for those who have had some elementary reading on the subject, or who are able at once to attack a more advanced work, and is intended to place before such the leading facts and principles. Among its features are the incorporation of numerical examples to be worked out by the student, and descriptions of experiments to be repeated. While the author rejoices at the disappearance of the method of studying a science from a text-book alone, he suggests that too much as well as too little time may be spent over experimental science; "mental inertia is as possible in the laboratory as in the lecture room." An elementary chapter in thermo-dynamics is given, with an attempt to explain and illustrate by examples the first two laws and the meaning of Joule's and Thomson's experiments. (Longmans, Green & Co., New York. Price, $1.50.)

In connection with the system of meteorological observations established by the Smithsonian Institution, a collection of meteorological tables was compiled by Dr. Arnold Guyot, and published in 1852 as a volume of the Miscellaneous Collections. Second and third editions were published in 1857 and 1859, and a fourth in 1884—all the successive issues being revised and added to. The editions having been exhausted, the work has been recast; and the tables are divided into three parts—Meteorological Tables, Geographical Tables, and Physical Tables—each representative of the latest knowledge in its field, and independent of the others; but the three forming a homogeneous series. The first of these parts—*Smithsonian Meteorological Tables*—now published, is, therefore, essentially a new publication. It is conformed, as far as practicable, with the International Meteorological Tables. A large number of tables have been newly computed.

Cortlandt F. Bishop contributes to the Columbia College Series in History, Economics, and Public Law a study in the *History of Elections in the United States*. General and local elections are considered separately. The history is given for each of the several colonies. The qualifications required of electors

are classified as ethnic, political, moral, religious, those of age, sexual, residential, those of property, and miscellaneous; and the conditions regulating the admission of freemen are described. The account of the management of elections includes many particulars of routine, with provisions against fraud, proceedings in contested elections, the privileges of voters, compulsory voting, bribery and other means of influencing voters, and the sanction of the election laws. Local elections are classed as town elections, parish elections, and municipal elections. Additional documental and tabular information is given in the appendices.

Mr. *Arthur J. Maginnis's* volume on *The Atlantic Ferry; its Ships, Men, and Working*, was the first work in which the transatlantic steam trade was fully described in all its parts and all its relations. It was, however, a large volume and expensive. A popular edition of the work is now published in which, by the omission of a few chapters not of great interest to the general public, and of illustrations whose value is mainly technical, the public demand and the average purse are more directly catered to. It embodies a careful and complete record of the doings of the great transatlantic steamship companies from early days to the present time. (Macmillan & Co., New York.)

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POPULAR MISCELLANY.

Political Science at the Brooklyn Institute.—The School of Political Science of the Brooklyn Institute announces an advance course in American politics, conducted by Dr. Lewis G. Janes. It will be the aim of the instructor to give a concise and correct history of our national politics from the Revolutionary period to the present time, with some account of the great statesmen and political leaders of our country. A clear statement of the facts of each political situation, with a just view of the great legal and constitutional questions involved in our political controversies, without partisan bias, will enable the student to form an intelligent judgment upon the several topics. The lectures of the first term will be devoted to the formative period of our politics, from the Revolution to the Mexican War; those of the second term to the period of reconstruction, from the Mexican War to the present Five discussions are also provided for, concerning the relative influence of the ideas of Jefferson and of Hamilton in molding American institutions; the good or evil of the influence of Andrew Jackson in our politics; the justice of the Mexican War; the impeachment of President Johnson; and the wisdom of President Cleveland's pension vetoes. The courses will be given to two classes, in two sections of Brooklyn, on different evenings of the week.

The Grave of R. A. Proctor.—Prof. Richard A. Proctor, the eminent astronomical writer, died in this city on his way from his home in Florida to fulfill lecture engagements in England, September 12, 1888, of yellow fever. The attack was sudden, and death followed very quickly. None of his family were near him, and he was buried by strangers in the lot in Greenwood Cemetery owned by the undertaker who took charge of his remains. No further care seems to have been taken of his grave until attention was called to its neglected condition through dispatches published in the papers by Mr. Edward J. Bok. A lot was then provided and a suitable monument was ordered by Mr. G. W. Childs, of Philadelphia, and on October 3, 1893, the remains were removed to this lot in the presence of a number of citizens, thus expressing their regard for Prof. Proctor's memory and for his services to science, with religious exercises and a eulogy by the Rev. Dr. T. De Witt Talmage. The lot in which the remains have been permanently interred is near the Fort Hamilton Avenue entrance to Greenwood Cemetery, opposite the village of Flatbush, and is surrounded by a substantial railing. The monument is of polished bluish Quincy granite, and besides the formal record bears the following tribute by Herbert Spencer: "On public as on private grounds Prof. Proctor's premature death was much to be lamented. He united great detailed knowledge with broad general views in an unusual degree, and, while admirably fitted for a popular expositor, was at the same time well equipped for original investigation, which, had he lived, would have added to our astronomical knowledge. Prof. Proctor was also to be admired for his endeavors to keep the pursuit of science free from the corrupting and paralyzing influence of state aid. HERBERT SPENCER."

Inductoscripts.—At the Nottingham meeting of the British Association for the Advancement of Science an interesting feature was introduced in the display of novel scientific apparatus and exhibits. Among these were the "inductoscripts" of Rev. F. J. Smith, obtained by placing an ordinary photographic plate, film upward, on a metal plate. A coin, or other metallic conductor with a design upon it, is then laid on the film and a discharge of electricity is passed from the coin to the metal plate. On developing the photographic plate in the ordinary way the design of the coin appears upon it. An instrument designed by Prof. Milne, F. R. S., of Japan, for registering the intensity of earth tremors, was also exhib-

ited. A pyrometer of platinum, in which was measured the electrical resistance of the metal when exposed to high temperatures, was shown by Mr. Callendar. The display of electrical apparatus also included a very fine high-resistance galvanometer designed by Prof. Oliver Lodge for physiological work; and a magnetic curve-traces contributed by Prof. Ewing. An instrument invented by Mr. John Anderton for projecting solids on a screen attracted much attention. Prof. Boys exhibited photographs of flying bullets, and Dr. Isaac Roberts some admirable photographs, chiefly of nebulæ, showing the probable formation of heavenly bodies. The marked success of the exhibition may lead to like collections being displayed at future meetings of the American Association.

Diversity of Forms and Conditions of Animal Life.—In a paper presented to the Convention of the College Association of the Middle States and Maryland, Dr. Spencer Trotter, speaking of the diversity of life on the earth's surface, remarks upon its correspondence, in a broad way, with the diversity of surroundings. Aquatic animals, like fishes, crayfish, and many insects, inhabit the waters of ponds, lakes, and streams. Frogs and other amphibious creatures are denizens of bays and streams. Some snakes and turtles are aquatic, while others are wholly lovers of the dry land. Birds are found in every situation: ducks and divers on the lakes and rivers; herons and bitterns in marshy fens; gulls and petrels on the open sea; sandpipers along the shores; eagles on lofty mountain peaks; while a host of species enliven the woods and fields. The haunts of mammals are no less diversified. The tree-loving squirrels, the burrowing ground hog, the mole digging out its long subterranean galleries, the water-loving beaver and otter, are each and all associated in the mind with their favorite surroundings. The idea of the animal and its particular home is not new. The story is told in peculiar language in Psalm civ: "The cedars of Lebanon, which he hath planted; where the birds make their nests: as for the stork, the fir trees are her house. The high hills are a refuge for the wild goats; and the rocks for the conies." If this diversity of life is so apparent in a limited area, it is far more so when we come to journey over an extended portion of the earth's surface. As the horizon widens newer and more significant features rise into view. Lofty mountain ranges, broad seas, trackless deserts, treeless plains, and vast forests successively present themselves. Climate and vegetation change from one region to another, and it is not a matter of surprise to find corresponding changes in animal life. Many kinds of animals are limited to particular regions, while others range through wide areas of country under a variety of physical changes. A traveler starting on the Atlantic seaboard of the United States and journeying westward along the fortieth parallel will pass successively through a number of distinct regions, each characterized by certain conditions of climate, vegetation, and peculiar animals. A number of familiar forms will, however, be found throughout the entire extent of the journey across the continent. If the traveler cross the Pacific to Japan, he will find forms of familiar types, though the species are all different from those he knew in America. Should he sail westward by the shortest route to England, he would pass the shores of countries wholly different from those he had left and from each other, each tenanted by strange forms of life—beasts, birds, reptiles, insects, and vegetation—distinct from any he had previously seen. In England, he would be struck by the likeness of the birds to those of Japan, while he would see none of the familiar species of North American birds. We learn from a survey of these conditions how intimately related an animal is to the earth, and how each species is fitted to the special conditions of the region it inhabits.

Crocodiles, Alligators, and the Heloderm.—Crocodiles from the Nile, India, and Ceylon share the tanks at the London Zoölogical Gardens with the alligators from America. The crocodile, says an English writer who has observed them, evidently bears the same analogy to the alligator as the frog to the toad. It is lighter in color and in build, and a more active as well as a more malicious creature. It is not so entirely hideous, though the lower jaw shows projecting tusks like those of a wild boar. The creature's eyes, celebrated in connection with the "crocodile tears"

with which legend declared that it attracted its sympathizing victims to the bank of the stream, are highly decorative, if not beautiful. The head, narrow and flat, resembles the head of a snake; the nose is sharp, and the fixed and motionless eyes are of the palest dusty gold, set in a short, horny pillar of a deeper golden brown. The crocodile's coat of armor is less complete than that of the alligator, and its quick, vivacious movements make it far more troublesome to the keepers when the tank has to be refilled and cleaned than the big alligators, which will allow themselves to be used as stepping-stones as the water ebbs away. "The heloderm, a fat and torpid lizard from Arizona, is supposed to be the sole existing member of its tribe, which possesses not only the poison glands that exist in most of the toads, but also the true poison teeth, with a channel for the emission of the venom. The lizard is about a foot and a half long, with a fat, fleshy body, a round tail ending in a blunt point, and a flat head with squared sides, resembling a small padlock. The whole body is covered with a curious coat of scales, like black and pink beads, arranged in an arabesque pattern. In its daily life it is a dull and stupid creature, feeding mainly on eggs, which it breaks and laps with its tongue. Its first and only victim was a guinea-pig that was put into its cage with a view to testing the reports as to its poisonous nature, which were by no means universally credited. The lizard bit the guinea-pig in the leg, and the animal died in a minute and a half, almost as soon as after the bite of a cobra."

Fresh Air for Legislators.—The Speaker of the British House of Commons recently pointed out a great need of the house over which he presides, and of other legislative bodies as well. Having arrived at Leamington for a little rest, he expressed his pleasure at finding himself there, "under the open air of heaven," after scenes of great anxiety and responsibility. There are very few men, as the Lancet remarks, commenting on this observation, having business of their own to attend to who can stand the work of Parliament from three in the afternoon till twelve at night without breaking down. The air of the house—whatever the "scientific ventilation"—is not the "open air of heaven." In addition to the want of air and want of space, are the temperature of discussion and the tension of highly strung men greatly differing in opinion. The Speaker is quoted as saying that the deterioration of members in health is evident from day to day, and that he sees men gradually becoming degenerate. He has been told by a cabinet minister, who is a peer, that he can recognize members of the House of Commons "by their pallid countenances," and can distinguish between them and members of the House of Lords. "It is the height of unreason to expect good legislation under such absurd conditions."

Requisites of a Flying Machine.—The principle seems to be accepted now by most of the students of aërial navigation that the successful air vessel, instead of a balloon, must be a body heavier than the air, and must be sustained as well as propelled in some way similar to that by which a bird flies. This principle was fully set forth in The Popular Science Monthly for January, 1892, by M. G. Trouvé, whose aviator, therein described, had wings acting almost precisely like those of a bird. M. Trouvé proposed for his machine an ingenious motor, which was to be actuated by the alternate compression and expansion of a gas in a Bourdon tube. Previous to M. Trouvé's paper, articles setting forth the principle of "heavier than the air" had been published by Mr. O. Chanute, Prof. S. P. Langley, and Mr. H. S. Maxim, and several have been published since in American magazines and journals. A writer who discusses the subject of aërial navigation in the Boston Herald raises the objection to a wing-motion, such as M. Trouvé's aviator contemplates, that the power needed to secure the velocity which an oscillating machine would require would probably cause the machine to destroy itself by the violence of its own vibrations. He proposes instead to depend on an aëroplane to hold the machine in the air, and to use a screw propeller as a source of motive power. He would pattern and proportion the aëroplane after the position of the motionless wings of a loon in scaling descent, as after they have been paralyzed by a shot hitting the brain; place the screw in front, on the principle that an arrow can not fly except with its heavier end foremost, and

guide the machine by horizontal and vertical rudders. The machine may be started by causing it to descend an inclined plane, and then to move horizontally, when its course is that of a scaling bird, and the power is applied, with the rudders, to keep up and direct the motion. Few persons who have seriously considered the subject now doubt the possibility of aërial navigation on the principle of "heavier than the air." But the construction of a practicable machine demands a variety of gifts and resources not to be found in one man: there must be an inventor, a mechanical engineer, a mathematician, a practical mechanic, and a syndicate of capitalists.

The Earliest Historical Art.—The earliest condition of art in Egypt, says Prof. W. M. Flinders Petrie, stands in a far different light from that of the history of art in other countries. In the first place, it is as early as, or earlier than, any other source of art that we know. Other countries have largely borrowed from Egypt or from Mesopotamia, but these two great deltas have not had any external influence acting on them; they stood far in advance of the civilization of the rest of the world in the early ages, and their art appears to be the outcome of the first stable and well-organized governments that were known. Tranquillity and the command of large resources were needful before any great progress could be made in architecture or the imitative arts; and no land appears to have enjoyed such conditions before the dawn of the historical period in Egypt. We have, then, to deal with a state of things in which art was, in the course of actual growth, free from the influence of any external guidance, and with only its own antecedents to build upon. This art also stands apart in the fact that all traces of its origin and rise are absent. We are still as much ignorant as ever of the course of its development. Where the tentative stages are to be found which led up to the triumphs of the fourth dynasty is as yet a mystery. Certain sculptures, which are undoubtedly very early, have been assigned to the second and third dynasties solely on account of the style. But there is no absolute evidence of the date of a single sculpture or a single block before the first king of the fourth dynasty, Snefru (the predecessor of Khufu, or Cheops), under whom we find some of the most perfect works that ever were executed. In one line, however, there are remains of an earlier style. The rock carvings of Upper Egypt certainly date back to a long prehistoric age—an age when the ostrich and the elephant were familiar in Egypt. But these rude figures have no relation to the art of historical times; and we should as soon learn the history of the Parthenon from the weapons of the stone age in Greece as trace the Egyptian schools in the rude carvings of the primitive man.

Public Parks in Massachusetts.—The Trustees of Public Reservations of Massachusetts is a chartered body established for the purpose of providing a ready instrument by means of which any person or body of persons may insure the preservation of any beautiful or historical place in the State. This may be accomplished by putting the tract in its hands. It also receives money for the maintenance and adornment of such places. As the years pass, a variety of motives are found to inspire the giving of lands into the hands of the trustees. The largest recent instance of this confidence is the gift of twenty acres of fine woodland in Stoneham by Mrs. Fanny Foster Tudor, now deceased, named by her desire, in memory of her daughter, Virginia Wood, for which a maintenance fund—the Virginia Wood Fund—has been collected and invested by other friends. It appears, from facts collected by Mr. J. B. Harrison respecting the present provision of open spaces in Massachusetts, that the large areas of undivided common lands which were once to be found in most of the townships of the Commonwealth have all been allotted or sold to individuals, except in Nantucket, where there still remain at least one thousand acres open to the public. The Park Board and Water Board of Lynn have lately restored to public ownership about two thousand acres of woodland which was once a common of this large kind. The smaller commons which the first proprietors of townships almost invariably laid out for "training fields" and sites for "meeting houses" appear to be still the only public open places in most of the townships of the State. Some of them have been en-

croached upon, some have passed into the exclusive possession of the "first churches," some into the exclusive possession of the townships, and some are said to be still owned jointly by township and church. Where the towns have come into possession they have frequently given the charge of the commons to village or township improvement associations. Only a few of the rural townships have acquired new public open spaces in recent years. In Manchester public rights in certain sea beaches have been established and a long strip of roadside woodland has been deeded to the town in trust. In Sheffield a beautiful pine grove is held in trust for the public by five trustees. Georgetown has laid out nine small spaces within forty years. In the cities of the State the General Park Act, passed in 1882, has borne excellent fruit.

Sanitary and Climatic Influence of Forests.—Concerning the sanitary and climatic relations of forests, Mr. B. E. Fernow concludes, after a discussion of the subject, that the influence claimed for them in promoting greater purity of the air through the greater production of oxygen and ozone does not seem to be sufficient; that the protection they afford against sun and wind and consequent absence of extreme conditions may be considered a favorable factor; and that the soil conditions of the forest, which are unfavorable to the production and existence of pathogenic microbes, especially those of the cholera and yellow fever, and the comparative absence of wind and dust, in which such microbes are carried into the air, may be considered as constituting the principal claim for the hygienic significance of the forest. We may summarize, he says, by saying that the position of the forest as a climatic factor is still uncertain, at least as to its practical and quantitative importance, but that its relation to water and soil conditions is well established. As a climatic factor the forest of the plain appears to be of more importance than that of the mountains, where the more potent influence of elevation obscures and reduces to insignificance the influence of their cover. As a regulator of water conditions the forest of the mountains is the important factor; and since this influence makes itself felt far distant from the location of the forest, the claim for the attention of government and for statesmanlike policy with reference to this factor of national welfare may be considered as well founded. Every civilized government must in time own or control the forest cover of the mountains, in order to secure desirable forest conditions.

The Scrub Lands of Australia.—The London Times's correspondent, in his little book on Queensland, mentions the "lawyer vine" as the worst obstacle which the clearer of land in that country has to encounter. It is a kind of palm that grows in feathery tufts along a pliant stalk, and festoons itself as a creeper upon other trees. From beneath the tufts of leaves the vine throws down trailing suckers as thick as stout cords, armed with sets of sharp red barbs. These suckers sometimes throw themselves from tree to tree across a road that has not been lately used, and make it as impassable to horses as so many strands of barbed wire. When the vines escape from the undergrowth of wild ginger and tree-fern and stinging bush that fringes the scrub and coil themselves in loose loops upon the ground, they become dangerous traps for man and horse. In the jungle, where they weave themselves in and out of the upright growths, they form a net that at times defies every means of destruction but fire. The work of clearing ground thus encumbered is not light. In some districts it is done by Chinamen. They are not allowed to own freehold land in the colony, but scrub land is often leased to them to clear and use for a certain number of years. The ground, when it is cleared, is extraordinarily rich, and they appear to recoup themselves for their labor with the first crops they grow upon their leaseholds. The owner afterward has it in his power to resume his land, and the Chinaman passes on to clear and use the scrub. In this way the Chinese are employed as a sort of self-acting machine for the opening of the country. They devote themselves principally to the cultivation of fruit. A walk round a Chinese garden is an instructive botanical excursion, so many and strange are the edible varieties of fruit to which one is introduced. Spices, too, and flowers flourish under the care of the Chinamen, and the

fields of bananas and pineapples dotted with orange and mango orchards, which stretch for miles beside the sugar plantations, are nearly all Chinese. They ship fruit to the southern colonies, but their profits must be very small, for one of the principal complaints made against them is that they can make a living where a white man would starve. Nevertheless, it is found that when they hire themselves out to work they are not a very great deal cheaper than white men.

Worlds and Molecules.—In his lectures at Geneva and Lausanne, M. Raoul Pictet presented mechanics as an exact science, comprising chemistry and physics in its domain. The principal phenomenon of physics is astronomy. The laws of sidereal gravitation apply likewise to the smallest bodies on the earth, to infinitely small ones like the molecules, and also to the atoms. Thus we have a unity of matter in which atoms, uniting from molecules, these group themselves into bodies, and these form worlds. The attraction which controls infinitely large bodies may therefore be regarded as similar to that which unites infinitely little ones. If the atoms touched in a molecule, there would be no force capable of separating them. We are, however, acquainted with dilatation and various ways of separating the atoms and augmenting the distance between them. The hypothesis that they touch is, therefore, not admissible. To explain the theory of chemical phenomena, let us suppose a molecule, A, placed somewhere in sidereal space, having a rectilineal motion toward another molecule, B, immovable, and very remote. In its approach to B there will come a moment when A's motion will slacken. Then astronomical phenomena will end and the phenomena special to physics will begin. At last the molecule A will stop; it has become inert, and can not advance further toward B. It is bound by cohesion. If, now, we suppose a pressure to be imposed on A, to bring it down to B, physical phenomena will cease, the resistance of A will diminish with the distance, and finally the molecule will ally itself with B without touching it; then we have chemical phenomena. The force that unites A and B is affinity. M. Pictet supposes that the absolute zero of temperature, when bodies can no longer react upon one another, is found between these last two phases, and his idea is confirmed by experiment. When sulphuric acid with potash is cooled down to $-150°$ C. ($-236°$ Fahr.), no reaction is apparent. The bodies are no longer able to combine at that temperature, when occurs a complete death of such action. At $-80°$ C. ($-112°$ Fahr.), potassium remains unattacked in alcohol and water for whole days. A slight warming produces a small reaction; and if the temperature is raised a little more, combination takes place with energy and an explosion is produced.

Heating and Ventilation of Electric-lighted Buildings.—In his paper on the Heating of Large Buildings, A. R. Wolff, consulting engineer, shows that the introduction of electric lighting with isolated generating plants in large buildings has had a sensible effect on the solution of the heating and ventilating problem by practically conditioning the use of exhaust steam for heating. The quantity of steam required for heating such buildings is nearly equal to the amount used independently for their electric lighting. Since electric-light engines convert only about ten or fifteen per cent of the heat of the steam with which they are supplied into mechanical energy, from eighty-five to ninety per cent of it is retained in the exhaust steam, available and just sufficient, as a rule, to meet the heating and ventilating needs of the building. This means practically that a boiler capacity ample for the heating and ventilating will take care, in addition, of the electric lighting of a large building, or *vice versa;* and that in the winter months the electric lighting is secured at only a slightly increased fuel expense. It is this fact that makes it difficult for either city or district heating or electric-lighting companies to supply steam or electricity respectively to large buildings. They can not compete with the cheapness of generation of the isolated plant within the building. The facts that electric lights give out less heat and vitiate the atmosphere less than gas, and that they do not flicker, have also an important bearing on the problem of heating and ventilation. The fresh-air supply can be brought in at the top of the room, where there are no lights for it to blow out, and ex-

hausted at the bottom, in reversal of the ordinary process, and under this condition it does not produce the draft or cause the sudden cooling that are so objectionable under the usual method of ventilation.

Work of the United States Fish Commission.—In the work of the United States Commission of Fish and Fisheries, the summer of 1890 was spent by the steamer Albatross in Bering Sea, where the principal banks frequented by the cod were surveyed. The season was too short to complete the work, and it will have to be resumed at some future time. The position of the western margin of the continental platform was, however, defined for a considerable distance, and a good beginning was made toward a knowledge of those physical and biological features of the sea which relate to the habits and distribution of the fur seal and other aquatic mammals. By the surveys of the coasts of Washington, Oregon, and California, the contour of the continental border has been developed from the shore line into depths of two hundred fathoms as far south as Point Conception, while the region between that place and San Diego had been previously explored. Temperature, density, and biological observations in different parts of San Francisco Bay indicate that the waters of that region are not, as has hitherto been supposed, unsuited to the breeding of Atlantic coast oysters. A scientific investigation was made with the Albatross during the early part of 1891, under the direction of Prof. Alexander Agassiz, of the waters lying off the western coast of America between Cape San Francisco and the Galapagos Islands on the south and the Gulf of California on the north. The most extensive and important operations on the Atlantic coast were conducted in the interest of the oyster industry, in the coast waters of South Carolina and Maryland and Virginia, and in Long Island Sound. Dr. Bashford Dean, of Columbia College, was commissioned to study the methods of oyster culture practiced in European countries and to prepare a series of illustrated reports concerning them. The physical inquiries in the mackerel region off the southern New England coast, under the direction of Prof. William Libby, Jr., were continued in 1889 and 1890; and the investigations respecting the interior waters of the country were conducted in twelve States and Territories on an extensive scale and with important practical results. The work of the Division of Fish Culture was continued at twenty-two stations in fifteen States.

The Theory of Special Assessments.—According to the study of this subject made by Victor Rosewater (Columbia College Series), the underlying principle of special assessment for benefit first appeared in this country in the provisions of a provincial law of New York in the year 1691. The effective clause of this statute was copied from an English act passed in 1667, and re-enacted in 1670, to regulate the rebuilding of London after the great fire. Thus the idea was not, as some have supposed, a native American one, but the substance of the plan had been put into English books twenty years before. The New York law remained unrepealed, but inoperative, till 1787, when it was adapted more closely to existing necessities. This method of raising revenue for local improvements remained for a long time peculiar to New York. It did not begin to extend to the other commonwealths till after the people had begun to recover from the effects of the War of 1812. The first development of the system, therefore, corresponds roughly with the movements for the construction of internal improvements covering the years just before and after 1830, and dying out with the crisis of 1837. The era of premature railway building about 1850 witnessed another movement of the kind in the newer States and Territories. The last movement, begun immediately after the close of the civil war, was more general than the others; has not yet wholly ceased; and has passed over into Toronto, Canada. The justification of the policy of special assessments is to be found in the principle that where an expense is to be incurred by a local authority which results in special, distinct, and measurable advantages to the property of particular persons, it is more equitable that those who benefit thereby should contribute to the expense to the extent of those benefits than that the burden should be placed upon others who have received no such special advantages. Among other methods of recovering the expense of improvements, besides

general taxation, are the imposition of tolls, which has now been generally abandoned, and recoupment, or buying the property before the improvement is made—as in the opening of new streets and public places—and reselling it afterward, which involves a large outlay of capital, and runs counter to the generally existing constitutional provisions respecting the exercise of eminent domain. For young and growing municipalities the method of special assessment is considered the best. "With few exceptions and abuses, it has been operated in the United States to the general satisfaction of all. It rests upon principles of right and justice. It brings quick results at the very time when needed. It discourages the speculative holding of unimproved urban property."

Characteristics of Lunar Craters.—In the study of lunar physiography or physiognomy, says Prof. G. K. Gilbert, interest naturally centers in the craters, for these are the dominant features. All theories begin with them. Their range in size is great, extending from a maximum of about eight hundred miles in diameter to a minimum of less than one mile. The size of the smallest ones is not known, as they are beyond the present power of the telescope. Within this range are several varieties, more or less correlated in size, but their intergradation is so perfect that they are all regarded as phases of a single type. To describe them one should picture to himself a circular plain, ten, twenty, fifty, or one hundred miles in diameter, surrounded by an acclivity which everywhere rises steeply but irregularly to a rude terrace, above which is a circular cliff likewise facing inward toward the plain. This cliff is the inner face of a rugged, compound, annular ridge, composed of shorter ridges which overlap one another, but all trend concentrically. Seen from above, this ridge calls to mind a wreath, and it has been so named. From the outer edge of the wreath a gentle slope descends in all directions to the general surface of the moon, which it is convenient here to call the outer plain. The outer slope of the crater may be identical in surface character with the outer plain, or it may be radially and somewhat delicately ridged as though by streams of lava. The inner slope from the base of the cliff to the margin of the inner plain is broken by uneven and discontinuous terraces. From the center of the inner plain rises a hill or mountain, sometimes symmetric but usually irregular and crowned by several peaks. From the outer plain to the base of the wreath the ascent is one thousand to two thousand feet, and the ascent thence to the top of the wreath may be as much more. The descent from the wreath to the inner plain is ordinarily from five thousand to ten thousand feet, and the height of the central hill is from one thousand to five thousand feet. With rare exceptions the inner plain is several thousand feet lower than the outer plain. The central hill is not universally present, but appears in rather more than half the craters of medium size, and tends to disappear as the craters become larger. Mr. Gilbert attempts to account for the origin of these craters by collisions of meteoric bodies with the moon, or of the moonlets by the aggregation of which under the meteoric theory the moon has been formed, and is supported by the fact that the splash produced by dropping a pebble into pasty mud, etc., has the form of a crater.

The Royal Cinnamon of Tonkin.—The cinnamon of Thanh-Hoa, Tonkin, called royal cinnamon, is highly esteemed by the Annamites, and great value is attached to pieces of its bark as presents. It is not cultivated, but grows in thick, hardly accessible forests on the Muong Mountains, where some cantons are tributary to Annam. Each canton must furnish the king a tribute of three stools of cinnamon a year. When an inhabitant learns of a stool, he immediately informs the mayor of his village; the mayor informs the sub-prefect, and he advises the governor of the province of the fact, who makes report of the matter to the court. The Quang phu, or sub-prefect, sends a squad of men to guard the tree, who are not relieved till the crop is gathered, in the presence of the Quang phu or of some mandarin deputized by him. The whole crop is supposed to go to the king, but the officers know how to retain a little of it. So precious a spice as is this particular kind has not entered into commerce, and so jealously is it guarded that it is extremely difficult to

obtain a specimen except through some fraud; and persons detected in defrauding the government of its cinnamon usually have to atone for the offense with their lives.

A Himalayan Landscape.—Mr. W. M. Conway, the Himalayan explorer, describes the view as an astonishing one which surrounds the traveler from Srinagar to Gilgit when he has emerged from the defiles which sunder the valley of Hunza Nagyr from Gilgit, and has climbed the vast ancient moraines near Tashot that form the final rampart of the fertile basin. "The bottom of the valley is, as usual, deeply furrowed by *débris*, the surface of which is covered by terraced fields, faced with Cyclopean masonry, and rich with growing crops and countless fruit trees. The mountains fling themselves aloft on either hand with astounding precipitousness, as it were, into the uppermost heights of heaven—so steeply, in fact, that a spring avalanche falling from the summit of Rakipershi on the south must almost reach the bottom of the valley. Rakipershi is 25,500 feet high; the Hunza peak is about 24,000 feet high. Their summits are separated by a distance of nineteen miles. Both mountains are visible from base to summit at one and the same time from the level floor of the valley between them, which is not more than 7,000 feet above the sea. No mountain view I saw in the Karakorums surpasses this for grim wonder of colossal scale, combined with savage grandeur of form and contrast of smiling foreground."

Composition of Clays.—The word clay, says Mr. Robert T. Hill, in his paper (United States Geological Survey) on the Clay Materials of the United States, has a diverse and elastic meaning. To the popular mind it is the familiar, gritless, plastic earth which is readily molded when wet. To the manufacturer it is the material he molds and bakes, which may be the natural plastic material of the popular mind, or a mixture of many ingredients either natural or artificial, according to the refinement of the ultimate product; this product varies as to simplicity of processes from the ordinary brick clays, which are natural mixtures of the essential sand and clay with iron and other accessories, to the washed, ground, screened, and compressed mixture of kaolin, feldspar, flint, and plastic clay from which the potter shapes china and porcelain into works of art. Clay material in nature is not always plastic, and many of the most valuable products are made from consolidated rock, as the Cornwall stone or rock kaolin, which is a crumbling granite. Many common brick clays are more like impure sand than clay, and some of these, from the earliest times, have been molded with straw to give them sufficient tenacity for the handling necessary before burning. Much of the aboriginal pottery of America is composed of various earths, with just enough clay to hold the particles together. The chief function of clay in the fictile arts is its partial fusion upon firing, and upon this and the skill of the artisan who fires the kiln depends the product, which is wonderfully varied by the mixtures of fluxes and tempering material. Plasticity is desirable for the handling of the unfired material. Nearly all unconsolidated or powdered material may be made to adhere by water and other ingredients than clay, so that it can be shaped for burning, but plastic clay is the cheapest natural material used for this purpose in all clay burning. The material for the coarse products occurs naturally, and is mixed with the non-plastic kaolins by the porcelain-maker to give the "clay" the necessary tenacity for handling and shaping.

NOTES.

An Experimental Study, by William O. Krohn, of simultaneous stimulations of the sense of touch, made upon ten different persons, among its interesting results showed that skin over the joints is much more sensitive than at other places; that touches on the back of the body are more distinctly felt, more clearly remembered, and therefore better localized than on the front part of the body; that the localizations are better for points not on the median line than for those on it; that they are not so correctly made on the left as on the right side of the body; that they are better on hairy portions than on those not covered with hairs; and that a difference in the power of correct localization exists between usually clothed and usually unclothed parts; the parts not covered, except in case of the joints, giving the more correct localizations.

By exposing hen's eggs to the vapors of alcohol for periods ranging from twenty-six to forty-eight hours, M. Ch. Féré has ascer-

tained that their development is much retarded and often results in the production of monstrosities. In some instances alcoholized eggs of nearly a hundred hours were hardly as far developed as normal eggs of twenty hours. These facts may be regarded as having a bearing on the frequency of sterility and premature abortions in human beings afflicted with alcoholism. They show, further, that alcohol may have an effect on the embryo, even when the progenitors have not been subject to chronic alcoholism.

The character of the writing found in the Maya codices and inscriptions has been a topic of discussion among students of the subject, and three theories have been sustained: one that the symbols are ideographic; another, that they are chiefly phonetic; and a third, or middle theory, by Dr. Brinton, that they are in the nature of rebus-writing, or "iconomatic." The personal statements of certain old Spanish writers—particularly of Bishop Landa, who assumed to publish the alphabet—are in favor of their phonetic character. This is also maintained in a recent paper—Are the Maya Hieroglyphics Phonetic?—by Dr. Cyrus Thomas, who presents interpretations which, he believes, if they are accepted, will settle the question.

At the last annual meeting of the New York Society for the Suppression of Vice, the president, Mr. Samuel Colgate, spoke of the encouragements that existed for the continuance of the work. The money receipts for the year 1892 had been equal to those of any previous year. The large proportion of prisoners convicted to the number brought to trial is cited as showing that the society is careful in instituting prosecutions. Several evidences were cited to show that the society had been brought into closer touch with public sympathy than ever before; among them was the fact that the year had been exceptionally free from newspaper assaults and adverse criticisms. Yet defects in the law needing amendment, and even legislation in favor of vice, and frequent laxity in the administration of existing laws, were complained of.

A university course of thirty lectures on Celestial Mechanics, by G. W. Hill, is now in progress, beginning October 14, 1893, at Hamilton Hall, Columbia College. The lectures are given every Saturday except the last two in December, at 10.30 a. m. A full presentation of the subject is given, rather than a rapid summary.

M. Janssen has telegraphed the fact that the observatory on the summit of Mont Blanc is completed, and nothing now remains to be done but carry out the interior arrangements. The machinery adopted for hauling materials up over the snow worked to perfection and contributed greatly to the success and comfort of the workmen. M. Janssen used it to assist in his own getting up, and it was "curious, extraordinary," he says, "to see materials moved by these engines climbing over the icy slopes of the peak by ways of a new sort, which science only was able to contrive and realize."

In an interference experiment described by Lord Rayleigh the light from a single slit, illuminated either by sunlight or a lamp flame, passes down a tube about a foot long and is received on two very fine and very close slits. An eye placed at the back of these sees a beautiful set of interference bands. No lens is required, because the eye itself acts as such. The two slits are really scratches made by a knife on an evenly silvered microscope cover-glass.

The consultative committee appointed in Italy to study the question of alcoholism has recently presented its report to the Government. It appears from the document that the yearly mortality ascribed to alcoholism for the whole kingdom is 1·62 per hundred thousand inhabitants. It was greatest in Liguria (3·46) and the March (3·11), and least in Campania (0·53) and the Abruzzi (0·75). Under the application of the new penal code, which makes intoxication a crime, 16,504 offenses were reported in 1890 and 16,382 in 1891.

In a paper on the wearing of rings in ancient Rome, M. Maximin Deloche shows that in the early days of the republic the iron ring was reserved for persons who had distinguished themselves by some splendid act in war or had rendered the state some important service. Afterward, patricians, knights, and magistrates had the privilege of wearing it. When the wearing of rings became general the metal used became the distinctive sign of the several classes of citizens, and the metal worn was determined by birth. The most precious metals were worn by the *ingenui;* senators and knights alone had golden rings; while the plebeians' rings were of iron. The freedmen in time made claims to the privilege of wearing gold, and it was given to them by a constitution of Justinian.

Noticing the fact that the Smithsonian Institution has obtained a table in the Zoological Laboratory at Naples, the Revue Scientifique remarks that it is curious that Americans should go to Europe to seek subjects for study when they have so abundant and varied a fauna at home.

A manufactory of flints for guns and tinder boxes still exists at Brandon, England, in which, according to Mr. Edward Lovett, the methods supposed to have been used in the stone age are employed without much change at the present time. The flint is broken into conveniently sized fragments by placing it on the knees and striking with a hammer. The pieces are then split into flakes, and these into squares, which are trimmed into

finished gun flints. Most of the gun flints are sent to Zanzibar and African ports, and the tinder-box flints to Spain and Italy.

A theory has been put forth by M. Rateau in the French Academy of Sciences that the crust of the earth beneath the continents does not touch the fluid globe, but is separated from it by a space filled with gaseous matter under pressure. The continents would therefore constitute a sort of blister, much flattened, inflated and sustained by gases, while the bottom of the oceans is supposed to rest directly on the fiery mass. By this hypothesis the author believes that many phenomena of the terrestrial crust may be explained which are not clearly accounted for under the present theory.

A rapid deterioration is described by Mr. C. H. Morse as being produced in the water pipes of Cambridge, Mass., by the electrolytic action of the current from the electric cars. It is observed in pipes composed of lead, iron, galvanized iron, brass, and rustless iron. In one instance the current was so strong as to set on fire oakum which was applied in making a joint. A partial check to the deterioration has been found in connecting the water and gas pipes and the negative pole of the dynamo.

The Bank of France has put in circulation notes printed on ramie paper. The notes are of the same form as the old-fashioned ones, but the new paper is lighter and at the same time firmer than the old, and permits a clearer impression, rendering counterfeiting more difficult.

Under the Thibetan system of polyandry, as observed by Mrs. Bishop (Isabella Bird), the eldest son alone of the family marries, and the wife accepts the brothers of her husband as secondary spouses. The whole family is thus held to the home. The children belong to the elder brother, while the other brothers are "lesser fathers." The natives are strongly attached to this custom. The women, in particular, despise the monotony of European monogamy, and the word "widow" is a term of reproach among them. Children are very obedient to their fathers and their mother, and the family feeling is strongly developed.

Strong additional evidence of the presence of cretaceous strata beneath the most of Long Island is adduced by Mr. Arthur Hollick, in a paper on that subject. They have been found in the shape of fossil remains of plants at Williamsburgh, Lloyd's Neck, and Glencove. Clays containing the fossils have been found in place in the neighborhood of Glencove; while at other sites the rocks appear to have been glacially transported. "Only a beginning," says Mr. Hollick, "has yet been made in the search for plant remains; but now that attention has been called to the matter they are being reported from a number of localities, and specimens are constantly coming to the light, and there seems to be no doubt that the entire north shore of the island will present the same story to the searchers when it has been carefully explored."

Trees in London, as in other cities, have two adverse influences to resist—coal smoke and the heat reflected from miles of brick and stone work. The past unusually hot summer has afforded a fine opportunity for observing what species can most successfully contend against these influences. Among them Mr. Herbert Maxwell names the Oriental plane tree, which has stood the trial fairly well, coming out with half its leaves gone and the other half fresh and green; aspens and poplars, which "have suffered not at all"; the ailantus, "which is (September 7th) in splendid foliage"; and our common locust (*Robinia pseudacacia*), which "for beauty of form or freshness of verdure can not be excelled for planting in towns."

OBITUARY NOTES.

Traugott Friedrich Kützing, a pioneer in the scientific study of the Algæ, died at Nordhausen, September 9, 1893, in the eighty-seventh year of his age. His latest work is more than twenty years old, and all his most important works appeared before 1851. Yet, although much that he did and taught has been superseded or supplemented by more recent investigations, his *Phycologia generalis*, published in 1843; his *Tabulæ phycologicæ*, published in twenty volumes, 1845 to 1870; and his *Species Algarum*, 1849, are still standard works. His extensive collection of dried Algæ has long been in the possession of the University of Leyden.

Dr. Alexander Strauch, Director of the Zoölogical Museum of St. Petersburg, who died in September, 1893, at the age of sixty-one years, was an authority on reptiles and the author of several zoological works.

Prof. Herman August Hagen, of Harvard College, a distinguished entomologist, died in Boston, Mass., November 9, 1893. He was born in Königsberg, Prussia, where his ancestors had been connected with the university for two hundred years, and, having pursued his studies there and at other places, settled there in the general practice of medicine. He was assistant in the surgical hospital there and incumbent of local civil offices when he was invited by Prof. Agassiz to come to Cambridge as assistant in entomology at the Museum of Comparative Zoölogy. In 1870 he was made Professor of Entomology at Harvard. His first scientific paper was published in 1834. His publications include more than four hundred articles, of which the most important is the Bibliotheca Entomologica.

DAVID STARR JORDAN.

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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XIX.—FROM CREATION TO EVOLUTION.

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PART I.

THE VISIBLE UNIVERSE.

ABOVE the portal of the beautiful cathedral of Freiburg may be seen one of the most interesting of thought fossils. A mediæval sculptor, working into stone various theological conceptions of his time, has there represented the creation. The Almighty, in human form, sits benignly making and placing upon the heavens, like wafers upon paper, sun, moon, and planets; and, at the center, platter-like and largest of all—the earth.

The furrows of thought on the Creator's face show that he is obliged to contrive; the masses of muscle upon his arms show that he is obliged to toil; naturally, then, the sculptors and painters of the mediæval and early modern period frequently represented him as the writers whose conceptions they embodied had done: as, on the seventh day, weary after thought and toil, enjoying well-earned repose and the plaudits of the hosts of heaven.

In this fossilized thought at Freiburg, and in others revealing the same idea in sculpture, painting, and engraving during the middle ages and the two centuries following, culminated a development of human thought which had existed through thousands of years, and which has controlled the world's thinking until our own time.

Its beginnings lie far back in human history; we find them among the early records of nearly all the great civilizations, and

they hold a most prominent place in the various sacred books of the world. In nearly all these there is revealed the conception of a Creator, of whom man is an imperfect image, and who literally and directly created the visible universe with his hands and fingers or voice.

Among these theories, of especial interest to us are those which controlled theological thought in Chaldea. The Assyrian inscriptions which have been recently recovered and given to the English-speaking peoples by such scholars as Layard, George Smith, Oppert, Sayce, and others, show that in the ancient religions of Chaldea and Babylonia there was elaborated a narrative of the creation which, in its most important features, must have been the source of that in our own sacred books. Or, at least, it has now become perfectly clear that from the same sources which inspired the accounts of the creation of the universe among the Chaldeo-Babylonian, the Assyrian, the Phœnician, and other ancient civilizations came the ideas which hold so prominent a place in the sacred books of the Hebrews. In the two accounts imperfectly fused together in Genesis, and also in the third account of which we have indications in the book of Job and in the Proverbs, there is presented, often with the greatest sublimity, that same early conception of the Creator and of the creation—the conception, so natural in the childhood of civilization, of a Creator who is an enlarged human being working literally with his own hands, and of a creation which is "the work of his fingers." To supplement this view there was then developed the belief in this Creator as one who, having

> "from his ample palm
> Launched forth the rolling planets into space,"

sits on high, enthroned "upon the circle of the heavens," perpetually controlling and directing them.*

Among the early fathers of the Church this view of creation became fundamental; they impressed upon Christendom more and more strongly the belief that the universe was created in a perfectly literal sense by the hands or voice of God. Here and

* A somewhat similar series of sculptures representing the Almighty creating the heavens and the earth is also to be seen at the cathedral of Upsala and elsewhere. For an exact statement of the resemblances which have settled the question among the most eminent scholars in favor of the derivation of the Hebrew cosmogony from that of Assyria, see Jensen, Die Kosmologie der Babylonier, Strassburg, 1890, pp. 304, 306; also, Franz Lukas, Die Grundbegriffe in den Kosmographien der alten Völker, Leipsic, 1893, pp. 35–46; also George Smith's Chaldean Genesis, especially the German translation with additions by Delitzsch, Leipsic, 1876, and Schrader, Die Keilinschriften und das Alte Testament, Giessen, 1883, pp. 1–54, etc. See also Renan, Histoire du peuple d'Israel, vol. i, chap. i, L'antique influence babylonienne.

there sundry theologians of larger mind attempted to give a more spiritual view regarding some parts of the creative work, and of these St. Augustine was chief. Ready as he was to bend his powerful mind to meet the literal text of Scripture, he revolted against the material conception of a creation of the visible universe by the hands and fingers of a Supreme Being, and in this he was followed by Bede and a few others; but the more material conceptions prevailed, and we find them taking shape not only in the sculptures and stained glass of cathedrals, and in the illuminations of missals and psalters, but later, at the close of the middle ages, in the pictured Bibles and in general literature.

Into the Anglo-Saxon mind this ancient material conception of the creation was riveted by two poets whose works appealed especially to the deeper religious feelings. In the seventh century Cædmon paraphrased the account given in Genesis, bringing out this material conception in the most literal form; and a thousand years later Milton developed out of the various statements in the Old Testament, mingled with a theology regarding "the creative word" which had been drawn from the New, his description of the creation by the second person in the Trinity, than which nothing could be more literal and material.*

"He took the golden compasses, prepared
In God's eternal store, to circumscribe
This universe and all created things.
One foot he centered, and the other turned
Round through the vast profundity obscure,
And said, 'Thus far extend, thus far thy bounds:
This be thy just circumference, O world!'

But as the evolution of theology proceeded, two new points in this materialistic view were especially developed. The first of these was that no material substance existed before the creation of the material universe—that "God created everything out of nothing." Some venturesome thinkers, basing their reasoning upon the first verses of Genesis, hinted at a different view—namely, that the mass, "without form and void," existed before the universe; but this doctrine was soon swept out of sight. The vast majority of the fathers were explicit on this point. Tertullian especially was very severe against those who took any other view than that generally accepted as orthodox; he declared that, if there had been any pre-existing matter out of which the world was formed, Scripture would have mentioned it; that by not mentioning it God has given us a clear proof that there was no such thing; and he threatens Hermogenes, who takes the opposite view,

* For Cædmon, see Bouterwek's edition, Gütersloh, 1854, vol. i; for Milton, see Paradise Lost, book vii, pp. 225–230.

with "the woe which impends on all who add to or take away from the written word."

St. Augustine, who shows signs of a belief in a pre-existence of matter, made his peace with the prevailing belief by the simple reasoning that, "although the world had been made of some material, that very same material must have been made out of nothing."

In the wake of these great men the universal Church steadily followed. The Fourth Lateran Council declared that God created everything out of nothing; and at the present hour the great majority of the faithful—whether Catholic or Protestant—are taught the same doctrine. On this point the syllabus of Pius IX and the Westminster Catechism fully agree.*

The other point of which there came a great theological development referred to the time occupied by the Almighty in the creation. The natural tendency of theology was, of course, more and more to glorify the great miracle; and, as a result of this tendency, it began to be held that the so-called Mosaic account of the creation in six days must be subordinated to the text, "He spake, and they were made," and that in some mysterious manner God created the universe in six days, yet brought all things into existence in a moment. Origen and Athanasius especially promoted this view in the East, and St. Augustine in the West.

Serious difficulties were found in reconciling these two views, which to the natural mind seemed absolutely contradictory; but by ingenious use or suppression of facts, by dexterous play upon phrases, and by plentiful metaphysics a reconciliation was effected, and men came at least to believe that they believed in a creation of the universe instantaneous and at the same time in six days.†

Some of the efforts to reconcile these two accounts were so fruitful as to deserve especial record. The fathers, Eastern and Western, developed out of the double account in Genesis, with the indications of the Psalms, the Proverbs, and the book of Job, a vast mass of sacred science bearing upon this point. As regards the whole work of creation, stress was laid upon certain occult powers in numerals. Philo Judæus had declared that the world was created in six days because "of all numbers six is the most productive"; he had explained the creation of the heavenly

* For Tertullian, see Tertullian against Hermogenes, chaps. xx and xxii; for St. Augustine regarding "creation from nothing," see the De Genesi contra Manichæos, lib. i, cap. vi; for St. Ambrose, see the Hexameron, lib. i, cap. iv; for the decree of the Fourth Lateran Council, and the view received in the Church to-day, see the article Creation in Addis and Arnold's Catholic Dictionary.

† For Origen, see his Contra Celsum, cap. xxxvi, xxxvii; also his De Principibus, cap. v; for St. Augustine, see his De Genesi contra Manichæos and De Genesi ad Litteram, *passim*; for Athanasius, see his Discourses against the Arians, ii, 48, 49.

bodies on the fourth day by "the harmony of the number four"; of the animals on the fifth day by the five senses; of man on the sixth day by the same virtues in the number six which had caused it to be set as a limit to the creative work; and, greatest of all, the rest on the seventh day by the vast mass of mysterious virtues in the number seven.

St. Jerome held that the reason why God did not pronounce the work of the second day "good" is to be found in the fact that there is something essentially evil in the number two, and this was echoed centuries afterward afar off in Britain by Bede.

St. Augustine brought this view to bear upon the Church in the following statement: "There are three classes of numbers—the more than perfect, the perfect, and the less than perfect, according as the sum of them is greater than, equal to, or less than the original number. Six is the first perfect number; wherefore we must not say that six is a perfect number because God finished all his works in six days, but that God finished all his works in six days because six is a perfect number."

Reasoning of this sort echoed along through the mediæval Church until a year after the discovery of America. It was re-echoed in the Nuremberg Chronicle as follows: "The creation of things is explained by the number six, the parts of which, one, two, and three, assume the form of a triangle."

This view of the creation of the universe in six days, each made up of an evening and a morning, as stated in the first of the accounts given in Genesis, became virtually universal. Peter Lombard and Hugo of St. Victor, authorities of vast weight in the Church, gave it their sanction in the twelfth century, and impressed it for ages upon the mind of the Church.

Both these lines of speculation—as to the creation of everything out of nothing, and the reconciling of the instantaneous creation of the universe with its creation in six days—were still further developed by sundry great thinkers of the middle ages.

St. Hilary, of Poictiers, reconciled the two conceptions as follows: "For, although according to Moses there is an appearance of regular order in the fixing of the firmament, the laying bare of the dry land, the gathering together of the waters, the formation of the heavenly bodies, and the arising of living things from land and water, yet the creation of the heavens, earth, and other elements is seen to be the work of a single moment."

St. Thomas Aquinas drew from St. Augustine a subtle distinction which for ages eased the difficulties in the case: he taught in effect that God created the substance of things in a moment, but gave to the work of separating, shaping, and adorning this creation six days.

In the seventeenth century the old view, in exact accordance

with the first of the two accounts in Genesis, was sanctioned by Bossuet. In his universal history he declared, "Moses teaches us that this Potent Architect wished to create the universe in six days to show that he did not act under necessity or blind impetuosity, as certain philosophers imagine."*

The early reformers accepted and developed the same view, and Luther especially showed himself equal to the occasion. With his usual boldness he declared, first, that Moses "spoke properly and plainly, and neither allegorically nor figuratively," and that therefore "the world with all creatures was created in six days." And then he goes on to show how, by a great miracle, the whole creation was also instantaneous.

Melanchthon also insisted that the universe was created out of nothing and in a mysterious way, both in an instant and in six days, citing the text: "He spake, and they were made; he commanded, and they were created."

Calvin opposed the idea of an instantaneous creation, and laid especial stress on the creation in six days; having called attention to the fact that the biblical chronology shows the world to be not quite six thousand years old and that it is now near its end, he says that "creation was extended through six days that it might not be tedious for us to occupy the whole of life in the consideration of it."

Peter Martyr clinched the matter by declaring: "So important is it to comprehend the work of creation in the faith that we see the creed of the Church take this as its starting point. Were this article taken away there would be no original sin, the promise of Christ would become void, and all the vital force of our religion would be destroyed." The Westminster divines in drawing up their Confession of Faith specially laid it down as necessary to believe that all things visible and invisible were created not only out of nothing but in exactly six days.

Nor were the Roman divines less strenuous than the Protestant reformers regarding the necessity of holding closely to the so-called Mosaic account of creation. As late as the middle of

* For Philo Judæus, see his The Creation of the World, chap. iii; for St. Augustine on the powers of numbers in creation, see his De Genesi ad Litteram, iv, ch. ii; for Peter Lombard, see the Sententiæ, lib. ii, dist. xv, 5; and for Hugo of St. Victor, see De Sacramentis, lib. i, pars i; also, Annotat. Elucidat. in Pentateuchum, cap. v, vi, vii; for St. Hilary, see De Trinitate, lib. xii; for St. Thomas Aquinas, see his Summa Theologica, quest. lxxxiv, art. i and ii; the passage in the Nuremberg Chronicle, 1493, is in fol. iii; for Bossuet, see his Discours sur l'Histoire Universelle; for the sacredness of the number seven among the Babylonians, see especially Schrader, Die Keilinschriften und das Alte Testament, pp. 21, 22; also George Smith *et al.*; for general ideas on the occult powers of various numbers, especially the number seven, and the influence of these ideas on theology and science, see my chapter on astronomy.

the eighteenth century, when Buffon attempted to state simple geological truths, the theological faculty of the Sorbonne forced him to make and to publish a most ignominious recantation which ended with these words: "I abandon everything in my book respecting the formation of the earth, and generally all which may be contrary to the narrative of Moses."*

But to these discussions was added yet another, which, beginning in the early days of the Church, was handed down the ages until it has died out among the theologians of our own time.

In the first of the biblical accounts light is created and the distinction between day and night thereby made on the first day, while the sun and moon are not created until the fourth day. Masses of profound theological and pseudo-scientific reasoning have been developed to account for this—masses so great that for ages they have obscured the simple fact that the original text is a precious revelation to us of one of the most ancient and universal of recorded beliefs—the belief that light and darkness are conditions or entities independent of the heavenly bodies, and that the sun, moon, and stars exist not merely to maintain or increase light but to "divide the day from the night, to be for signs and for seasons, and for days and for years," and "to rule the day and the night."

Of this belief we find survivals among the early fathers, and especially in St. Ambrose; in his work on creation he tells us: "We must remember that the light of day is one thing and the light of the sun, moon, and stars another—the sun by his rays appearing to add luster to the daylight. For before sunrise the day dawns but is not in full refulgence, for the sun adds still further to its splendor." This view became one of the "treasures of sacred knowledge committed to the Church," and was faithfully received by the middle ages. The mediæval mysteries and miracle plays give curious evidences of this: In a performance of the creation, when God separates light from darkness, the stage direction is, "Now a painted cloth is to be exhibited, one half black and the other half white." This theory, leaving out all quibblings and special pleadings, which in the light of modern

* For Luther, see his Commentary on Genesis, 1545, introduction, and his comments on chap. i, verse 12; the quotations from Luther's commentary are taken mainly from the translation by Henry Cole, D. D., Edinburgh, 1858; for Melanchthon, see Loci Theologici, in Melanchthon's opera, ed. Bretschneider, vol. xxi, pp. 269, 270; also pp. 637, 638; for the citations from Calvin, see his Commentary on Genesis (Opera omnia, Amsterdam, 1671, tom. i, cap. ii, vol. i, p. 8); also in the Institutes, Allen's translation, London, 1838, vol. i, chap. xv, pp. 126, 127; for Peter Martyr, see his Commentary on Genesis, cited by Zöckler, vol. i, p. 690; for the articles in the Westminster Confession of Faith, see chap. iv; for Buffon's recantation, see Lyell, Principles of Geology, chap. iii, p. 57.

knowledge are fast coming to be recognized as profoundly immoral, was without doubt the understanding and the belief of the person or persons who compiled from the Chaldean and other earlier statements the account of creation in the first of our sacred books.*

Thus down to a period almost within living memory it was held, virtually "always, everywhere, and by all," that the universe, as we now see it, was created literally and directly by the voice or hands of the Almighty, or by both—out of nothing—in an instant or in six days, or in both—and for the convenience of the dwellers upon the earth, which was at the base and foundation of the whole structure.

But there had been implanted along through the ages germs of another growth in human thinking, some of them even as early as the Babylonian period. In the Assyrian inscriptions we find recorded the Chaldeo-Babylonian idea of a development of the universe out of the primeval flood or "great deep," and of the animal creation out of the earth and sea. This idea, recast, partially at least, into monotheistic form, passed naturally into the sacred books of the neighbors and pupils of the Chaldeans—the Hebrews; but its development in Christendom afterward was checked, as we shall hereafter see, by the more powerful influence of other inherited statements which appealed more simply and powerfully to the mind of the Church.

Far more striking was the effect of this idea, rewrought by the early Ionian philosophers, to whom it was doubtless transmitted from the Chaldeans through the Phœnicians. In the minds of Ionians like Anaximander and Anaximenes it was most strikingly developed; the first of these conceived of the visible universe as the result of processes of evolution, and the latter pressed further the same mode of reasoning, dwelling on agencies in cosmic development recognized in modern science.

This geneal idea of evolution in Nature thus took strong hold upon Greek thought and was developed in many ways, some wonderfully ingenious, some curiously perverse. Plato, indeed, withstood it; but Aristotle sometimes developed it so as to remind us of modern views.

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* For scriptural indications of the independent existence of light and darkness, compare with the first verses of the first chapter of Genesis such passages as Job xxxviii, 19, 24; for the general prevalence of this early view, see Lukas, Kosmogonie, pp. 31, 33, 41, 74, and *passim*; for the view of St. Ambrose regarding the creation of light and of the sun, see his Hexameron, lib. 4, cap. iii; for an excellent general statement, see Huxley, Mr. Gladstone and Genesis, in the Nineteenth Century, 1886, reprinted in his Essays on Controverted Questions, London, 1892, note, pp. 126 *et seq.*; for the acceptance in the miracle plays of the scriptural idea of light and darkness as independent creations, see Wright, Essays on Archæological Subjects, vol. ii, p. 178.

Among the Romans Lucretius caught much from it, extending the evolutionary process virtually to all things.

In the early Church, as we have seen, the idea of a creation direct, material, and by means like those used by man, was all-powerful for the exclusion of conceptions based on evolution. From the more simple and crude of the two views of creation given in the Babylonian legends, and thence incorporated into Genesis, rose the stream of orthodox thought on the subject, which grew into a flood and swept on through the middle ages and into modern times. Yet here and there in the midst of this flood were to be seen high grounds of thought held by strong men. Scotus Erigena and Duns Scotus, among the schoolmen, bewildered though they were, had caught some rays of this ancient light, and passed on to their successors, in modified form, doctrines of an evolutionary process in the universe.

In the latter half of the sixteenth century these evolutionary theories seemed to take more definite form in the mind of Giordano Bruno, who evidently divined the fundamental fact of what is now known as the "nebular hypothesis"; but with his murder by the Inquisition at Rome this idea seemed utterly to disappear—dissipated by the flames which in 1600 consumed his body on the Campo del Fiore.

Yet within a generation after Bruno's death the world was introduced into a new realm of thought in which an evolution theory of the visible universe was sure to be rapidly developed. For there came, one after the other, five of the greatest men our race has produced—Copernicus, Kepler, Galileo, Descartes, and Newton—and when their work was done the old theological conception of the universe was gone; "the spacious firmament on high," "the crystalline spheres," the Almighty enthroned upon the circle of the heavens, and with his own hands, or with angels as his agents, keeping sun, moon, and planets in motion for the benefit of the earth, opening and closing the "windows of heaven," letting down upon the earth the "waters above the firmament," setting his bow in the cloud, hanging out signs and wonders, hurling comets, casting forth the lightnings to scare the wicked, and shaking the earth in his wrath—all this has disappeared.

These five men had given a new divine revelation to the world; and through the last, Newton, had come a vast new conception, destined to be fatal to the old theory of creation, for he had shown throughout the universe, in place of almighty caprice, all-pervading law. The bitter opposition of theology to the first four of these men is well known; but the fact is not so widely known that Newton, in spite of his deeply religious spirit, was also strongly opposed. It was vigorously urged against him that by his statement of the law of gravitation he "took from God

that direct action on his works so constantly ascribed to him in Scripture and transferred it to material mechanism," and that he "substituted gravitation for Providence." But, more than this, these men gave a new basis for the theory of evolution as distinguished from the theory of creation.

Especially worthy of note is it that the great work of Descartes, erroneous as many of its deductions were, and, in view of the lack of physical knowledge in his time, must be, had done much to weaken the old conception. His theory of a universe brought out of all-pervading matter, wrought into orderly arrangement by movements in accordance with physical laws—though it was but a provisional hypothesis—had done much to draw men's minds from the old theological view of creation; it was an example of intellectual honesty arriving at errors, but thereby aiding the advent of truths. Crippled though Descartes was by his almost morbid fear of the Church, this part of his work was no small factor in bringing in that attitude of mind which led to a reception of the thoughts of more unfettered thinkers.

Thirty years later came, in England, an effort of a different sort, but with a similar result. In 1678 Ralph Cudworth published his Intellectual System of the Universe. To this day he remains, in breadth of scholarship, in strength of thought, in tolerance, and in honesty, one of the greatest glories of the English Church, and his work was worthy of him. He purposed to build a fortress which should protect Christianity against all dangerous theories of the universe, ancient or modern. The foundations of the structure were laid with old thoughts thrown often into new and striking forms; but, as the superstructure arose more and more into view, while genius marked every part of it, features appeared which gave the rigidly orthodox serious misgivings. From the old theories of direct personal action on the universe by the Almighty he broke utterly. He dwelt on the action of law, rejected the continuous exercise of miraculous intervention, pointed out the fact that in the natural world there are "errors" and "bungles," and argued vigorously in favor of the origin and maintenance of the universe as a slow and gradual development of Nature in obedience to an inward principle. The Balaks of seventeenth-century orthodoxy might well condemn this honest Balaam.

Toward the end of the next century a still more profound genius, Immanuel Kant, took up the theory, and in the light of Newton's great utterances gave it a consistency which it had never before had; and about the same time Laplace gave it yet greater strength by mathematical reasonings of wonderful power and extent, thus implanting firmly in modern thought the idea that our own solar system and others, suns, planets, satellites, and

their various movements, distances, and magnitudes, necessarily result from the obedience of nebulous masses to natural laws.

Throughout the theological world there was an outcry at once against "atheism," and war raged fiercely. Herschel and others pointed out many nebulous patches yet in the gaseous form. They showed by physical and mathematical demonstrations that the hypothesis accounted for the great body of facts, and, despite clamor, they were gaining ground, when the improved telescopes resolved some of the patches of nebulous matter into multitudes of stars. The opponents of the nebular hypothesis were overjoyed; they now sang pæans to astronomy, because, as they said, it had proved the truth of Scripture. They had jumped to the conclusion that all nebulæ must be alike; that if *some* are made up of systems of stars, *all* must be so made up; that none can be masses of attenuated gaseous matter, because some are not.

Science halted for a time. The accepted doctrine became this: That the only reason why all the nebulæ are not resolved into distinct stars is that our telescopes are not sufficiently powerful. But in time came the discovery of the spectroscope and spectrum analysis, and this was supplemented by Fraunhofer's discovery that the spectrum of an ignited gaseous body is non-continuous, with interrupting lines; and this, in 1846, by Draper's discovery that the spectrum of an ignited solid is continuous, with no interrupting lines. And now the spectroscope was turned upon the nebulæ, and about one third of them were found to be gaseous. Here, then, was excellent ground for the inference that in these nebulous masses at different stages of condensation—some apparently mere patches of mist, some with luminous centers—we have the process of development actually going on, and observations like those of Lord Rosse and Arrest gave yet further confirmation to the scientific view. Then came the great contribution of the nineteenth century to physics, aiding to explain a most important part of the vast process by the mechanical theory of heat.

Again the nebular hypothesis came forth stronger than ever, and about 1850 the beautiful experiment of Plateau on the rotation of a fluid globe came in to illustrate if not to confirm it; even so determined a defender of orthodoxy as Mr. Gladstone at last acknowledged the nebular hypothesis as probably true.

Here, too, was exhibited that form of surrendering theological views to science under the claim that science concurs with theology, which we have seen in so many other fields; and as typical an example may be given, which, however restricted in its scope, throws light on the process by which such surrenders are obtained. A few years since one of the most noted professors of chemistry in the city of New York, under the auspices of one of

its largest churches, gave a lecture which, as was claimed in the public prints and in placards posted in the streets, was to show that science supports the theory of creation given in the sacred books ascribed to Moses. A large audience assembled, and a brilliant series of elementary experiments with oxygen, hydrogen, and carbonic acid was concluded by the Plateau demonstration. It was beautifully made. As the colored globule of oil, representing the earth, was revolved in a transparent medium of equal density, as it became first flattened at the poles, as rings then broke forth from it, and revolved about it, and, finally, as some of these rings broke into satellites, which for a moment continued to circle about the central mass, the audience, as well they might, rose and burst into rapturous applause.

Thereupon a well-to-do citizen arose and moved the thanks of the audience to the eminent professor for "this perfect demonstration of the exact and literal conformity of the statements given in Holy Scripture with the latest results of science." The motion was carried unanimously and with applause, and the audience dispersed, feeling that a great service had been rendered to orthodoxy. "*Sancta simplicitas!*" *

What this incident exhibited on a small scale has been seen elsewhere with more distinguished actors and on a broader stage. Scores of theologians, chief among whom of late, in zeal if not in knowledge, has been Mr. Gladstone, have endeavored to "reconcile" the two accounts in Genesis with each other and with the truths regarding the origin of the universe gained by astronomy, geology, geography, physics, and chemistry. The result has been recently stated by an eminent theologian, the Hulsean Professor of Divinity at the University of Cambridge. He declares, "No

* For an interesting reference to the outcry against Newton, see McCosh, The Religious Aspect of Evolution, New York, 1890, pp. 103, 104; for germs of an evolutionary view among the Babylonians, see George Smith, Chaldean Account of Genesis, New York, 1876, pp. 74, 75; for a germ of the same thought in Lucretius, see his De Naturâ Rerum, lib. v, 187–194, 447–454; for Bruno's conjecture (in 1591), see Jevons, Principles of Science, London, 1874, vol. ii, p. 299; for Kant's statement, see his Naturgeschichte des Himmels; for his part in the nebular hypothesis, see Lange, Geschichte des Materialismus, vol. i, p. 266; for value of Plateau's beautiful experiment, very cautiously estimated, see Jevons, vol. ii, p. 36; also Elisée Reclus, The Earth, translated by Woodward, vol. i, pp. 14–18, for an estimate still more careful; for a general account of discoveries of the nature of nebulæ by spectroscope, see Draper, Conflict between Religion and Science; for a careful discussion regarding the spectra of solid, liquid, and gaseous bodies, see Schellen, Spectrum Analysis, pp. 100 *et seq.*; for a very thorough discussion of the bearings of discoveries made by spectrum analysis upon the nebular hypothesis, ibid., pp. 532–537; for a presentation of the difficulties yet unsolved, see an article by Plummer in the London Popular Science Review for January, 1875; for an excellent short summary of recent observations and thought on this subject, see T. Sterry Hunt, Address at the Priestley Centennial, pp. 7, 8; for an interesting modification of this hypothesis, see Proctor's writings.

attempt at reconciling Genesis with the exacting requirements of modern sciences has ever been known to succeed without entailing a degree of special pleading or forced interpretation to which, in such a question, we should be wise to have no recourse."

The revelations of another group of sciences, though sometimes bitterly opposed and sometimes "reconciled" by theologians, have finally set the whole question at rest. First, there have come the biblical critics—earnest Christian scholars, working for the sake of truth—and these have revealed beyond the shadow of a reasonable doubt the existence of at least two distinct accounts of creation in our book of Genesis, which can sometimes be made to agree, but which are generally absolutely at variance with each other. These scholars have further shown the two accounts to be not the cunningly devised fables of priestcraft, but evidently fragments of earlier legends, myths, and theologies, accepted in good faith and brought together for the noblest of purposes by those who put in order the first of our sacred books.

Next have come the archæologists and philologists, the devoted students of ancient monuments and records; of these are such as Oppert, George Smith, the Rev. Prof. Sayce of Oxford, Jensen, Schrader, and a noble phalanx of similarly devoted scholars, who have deciphered a multitude of ancient texts, especially the inscriptions found in the great library of Assurbanipal at Nineveh, and have discovered therein an account of the origin of the world identical in its most important features with the later accounts in our own book of Genesis.

These men have had the courage to point out these facts and to connect them with the truth that these Chaldean and Babylonian myths, legends, and theories were far earlier than those of the Hebrews, which so strikingly resemble them, and which we have in our sacred books; and they have also shown us how natural it was that the Jewish accounts of the creation should have been obtained at that remote period when the earliest Hebrews were among the Chaldeans, and how the great Hebrew poetic accounts of creation were drawn either from the sacred traditions of these earlier nations or from antecedent sources common to various ancient nations.

In a summary which in its profound thought and fearless integrity does honor not only to himself but to the great position which he holds, the Rev. Dr. Driver, Royal Professor of Hebrew and Canon of Christ Church at Oxford, has recently stated the case fully and fairly. Having pointed out the fact that the Hebrews were one people out of many who thought upon the origin of the universe, he says that they "framed theories to account for the beginnings of the earth and man"; that "they either did this

for themselves or borrowed those of their neighbors"; that "of the theories current in Assyria and Phœnicia fragments have been preserved, and these exhibit points of resemblance with the biblical narrative sufficient to warrant the inference that both are derived from the same cycle of tradition."

After giving some extracts from the Chaldean creation tablets he says: "In the light of these facts it is difficult to resist the conclusion that the biblical narrative is drawn from the same source as these other records. The biblical historians, it is plain, derived their materials from the best human sources available. . . . The materials which with other nations were combined into the crudest physical theories or associated with a grotesque polytheism were vivified and transformed by the inspired genius of the Hebrew historians, and adapted to become the vehicle of profound religious truth."

Not less honorable to the sister university and to himself is the statement recently made by the Rev. Prof. Ryle, Hulsean Professor of Divinity at Cambridge. He says that to suppose that a Christian "must either renounce his confidence in the achievements of scientific research or abandon his faith in Scripture is a monstrous perversion of Christian freedom." He declares: "The old position is no longer tenable; a new position has to be taken up at once, prayerfully chosen, and hopefully held." He then goes on to compare the Hebrew story of creation with the earlier stories developed among kindred peoples, and especially with the Assyro-Babylonian cosmogony, and shows that they are from the same source. He points out that any attempt to explain particular features of the story into harmony with the modern scientific ideas necessitates "a non-natural" interpretation; but he says that if we adopt a natural interpretation "we shall consider that the Hebrew description of the visible universe is unscientific as judged by modern standards, and that it shares the limitations of the imperfect knowledge of the age at which it was committed to writing." Regarding the account in Genesis of man's physical origin, he says that it "is expressed in the simple terms of prehistoric legend, of unscientific pictorial description."

In these statements and in a multitude of others made by eminent Christian investigators in other countries is indicated what the victory is which has now been fully won over the older theology.

Thus, from the Assyrian researches as well as from other sources, it has come to appear and to be acknowledged by the most eminent scholars at the leading seats of Christian learning that the accounts of creation with which for nearly two thousand years all scientific discoveries have had to be "reconciled"—the accounts which blocked the way of Copernicus, and Galileo, and

Newton, and Laplace—were simply transcribed or evolved from a mass of myths and legends largely derived by the Hebrews from their ancient relations with Chaldea, rewrought in a monotheistic sense, imperfectly reconciled, and then thrown into a poetic form in the sacred books which we have inherited.

On one hand, then, we have the various groups of men devoted to the physical sciences all converging toward the proofs that the universe, as we at present know it, is the result of an evolutionary process—that is, of the gradual working of physical laws upon an early condition of matter; on the other hand, we have other great groups of men devoted to historical, philological, and archæological science whose researches all converge toward the conclusion that our sacred texts were the result of an evolution from an early chaos of rude opinion.

The great body of theologians who have so long resisted the conclusions of the men of science have claimed to be fighting especially for "the truth of Scripture," and their final answer to the simple conclusions of science regarding the evolution of the material universe has been the cry, "The Bible is true." And they are right—though in a sense nobler than they have dreamed. Science, while conquering them, has found in our Scriptures a far nobler truth than that literal historical exactness for which theologians have so long and so vainly contended. More and more as we consider the results of the long struggle in this field we are brought to the conclusion that the inestimable value of the great sacred books of the world is found in their revelation of the steady striving of our race, in obedience to divine law, after higher conceptions, beliefs, and aspirations, both in morals and religion. Unfolding this long-continued effort, each of the great sacred books of the world is precious, and all in the highest sense are true. Not one of them, indeed, conforms to the measure of what mankind has now reached in historical and scientific truth; to make a claim to such conformity is folly, for it simply exposes those who make it and the books for which it is made to loss of their just influence.

That to which the great sacred books of the world conform, and our own most of all, is the evolution of the highest conceptions, beliefs, and aspirations of our race from its childhood through the great turning points in its history. Herein lies the truth of all bibles, and especially of our own. Of vast value they indeed often are as a record of historical outward fact; recent researches in the East are constantly increasing this value; but it is not for this that we prize them most—they are eminently precious, not as a record of outward fact, but as a mirror of the evolving heart, mind, and soul of man. They are true because they have been developed in accordance with the laws governing

the evolution of truth in human history, and because in poem, chronicle, code, legend, myth, apologue, or parable they reflect this development of what is best in the onward march of humanity. To say that they are not true is as if one should say that a flower or a tree or a planet is not true; to scoff at them is to scoff at the law of the universe. In welding together into noble form, whether in the book of Genesis, or in the Psalms, or in the book of Job, or elsewhere, the great conceptions of men acting under earlier inspiration, whether in Egypt, or Chaldea, or India, or Persia, the compilers of our sacred books have given to humanity a possession ever becoming more and more precious; and modern science in substituting a new heaven and a new earth for the old —the reign of law for the reign of caprice, and the idea of evolution for that of creation—has added and is steadily adding a new revelation divinely inspired.

In the light of these two evolutions, then—one of the visible universe, the other of a sacred creation-legend—science and theology have at last been reconciled. A great step in this reconciliation was recently seen at the main center of theological thought among English-speaking people, when, in the collection of essays entitled Lux Mundi, emanating from the college established in these latter days as the fortress of orthodoxy at Oxford, the legendary character of the creation accounts in our sacred books was acknowledged, and when an archbishop suggested that the "Holy Spirit may at times have made use of myth and legend."*

In a communication to the Belgian Geological Society M. Dallo has called attention to some truly scientific conceptions expressed or foreshadowed by Dante in his great poem, including such truths as the moon the principal cause of the tides; the level, except for the relief of the waves, of the surface of the sea; the existence of a centripetal force, illustrated in the fall of bodies; the spherical form of the earth; that the land above the sea is simply a protuberance from the surface of the globe; that the continents are grouped in the northern hemisphere; the existence of universal attraction; that the elasticity of vapors is a motive power; that the continents have been upraised; and the existence of the chemical elements, more or less as they were conceived by Lavoisier.

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* For the first citations above made, see The Cosmogony of Genesis, by the Rev. S. R. Driver, D. D., Canon of Christ Church and Regius Professor of Hebrew at Oxford, in The Expositor for January, 1886; for the second series of citations, see The Early Narrations of Genesis, by Herbert Edward Ryle, Hulsean Professor of Divinity at Cambridge, London, 1892. For evidence that even the stiffest of Scotch Presbyterians have now come to discard the old literal biblical narrative of creation and to regard the declaration of the Westminster Confession thereon as a "disproved theory of creation," see Principal John Tulloch, in Contemporary Review, March, 1877, on Religious Thought in Scotland—especially page 550.

NOTES FROM A MARINE BIOLOGICAL LABORATORY.

By Prof. WILLIAM S. WINDLE.

FOR the past fifteen years it has been customary for the members of the Biological Department of the Johns Hopkins University to devote the summer vacations to pursuing their studies on the seashore. "The Johns Hopkins Marine Laboratory," as the organization is called, is under the direction of Prof. W. K. Brooks, and has been confined to no permanent location, but has been moved from place to place as the wishes of those interested demanded. Many seasons were spent in studying animal forms found in waters of the Chesapeake Bay. For a few years the laboratory was stationed at Beaufort, N. C. Then Green Turtle and Biminy Islands of the Bahamas were chosen as stations for biological research. Finally, the organization went so far south as the island of Jamaica. The site of the present marine laboratory is Port Henderson, Jamaica, where it was located two years ago. To secure best results in research upon embryonic forms, our party set out early for the sea. With full equipment for the laboratory we boarded the steamer Ryvingen and sailed down the Chesapeake Bay *en route* for the West Indies. The voyage was uneventful for the most part. After the lighthouses and white sandy hills of the Eastern Shore had disappeared beneath the horizon, we continued our course steadily to the southeast, with little to entertain us but occasional schools of flying fish and the flock of "Mother Carey's chickens" which followed our boat all the way. Large jellyfish and ctenophores floated by occasionally. On the fourth day out we passed Watling's Island, or San Salvador, and other smaller islands of the Bahamas. Next day we rounded the eastern coast of Cuba, and by using the captain's field glass could easily determine the characteristic features of the island. Its mountains appear quite high and rugged in the interior, and they slope rapidly by foothills and broad terraces down to the sea. The shores of Cuba afforded us our first glimpse of cocoanut palms, banana and sugar-cane plantations. It was a beautifully clear and starry night when we sailed into Windward Passage. The gray mountains of Cuba outlined against the northern horizon were slowly fading from view, when the crescent moon arose out of the waves in the east. The north star hung low, and in the south the Southern Cross appeared to us for the first time. With such new and charming surroundings we spent the evening very delightfully on deck. Not the least interesting was the phosphorescence in the waves and spray. Each crested wave, as it receded from the bow, seemed alive with hosts of glowing fireflies. It was a grand sight to watch the turbulent,

sparkling stream that followed in the ship's wake. Disturbed by the motion of propeller and rudder, millions of minute phosphorescent organisms were thrown to the surface like brilliant, sparkling gems. Now and then large ctenophores emerged from the depths, displaying rich halos of light for a moment, then disappeared in the surf. In no other place did we notice such rich displays of phosphorescence.

After a six-days' voyage we landed safely at Port Henderson, on the north side of Jamaica. Here we took carriages for a drive of sixty miles across the island to Kingston, its capital. The road

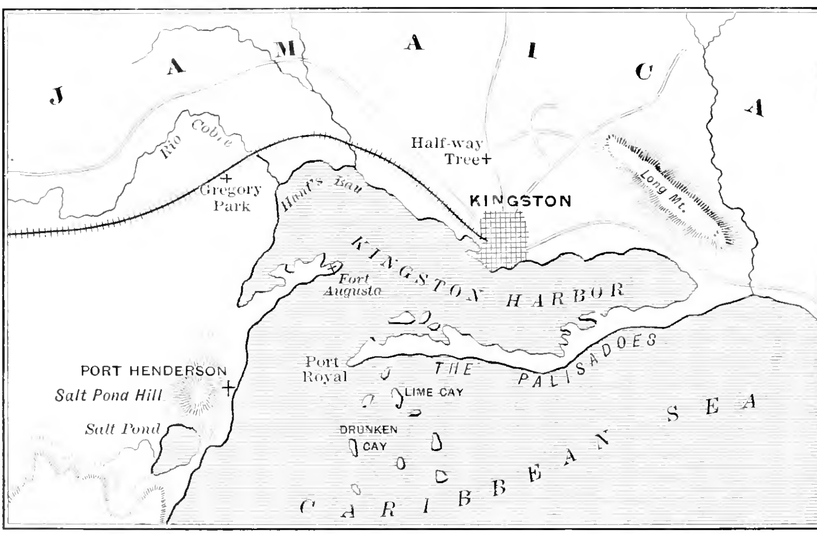

FIG. 1.—THE VICINITY OF KINGSTON.

we traveled was a well-built public thoroughfare, fully equaling the American "gravel road." It followed the coast line pretty closely for twenty-eight miles to Annotto Bay, then extended into the interior by way of the Wag Water River. Reaching the "divide" of the Blue Mountains, the road rapidly descended by a circuitous route into the broad valleys of the south side of the island. This drive across Jamaica affords the tourist a fair idea of its life and scenery. The majestic cocoanut palm, the luxuriant banana plant, and the feathery bamboo grace the landscape in every direction. The primitive bamboo cabins, with their dusky occupants, the barefooted market women, "John Crow" the buzzard, and "Old Joe" the pelican, soon become familiar objects to the tourist in the West Indies. On reaching Kingston we found our way through its narrow streets to Market Wharf, where we took passage on the steam launch Firefly for Port Henderson, our final destination. This is a little village of a dozen or more

buildings lying across the harbor to the southwest about four miles from Kingston. It is a seaside resort for Jamaicans of leisure, and a more attractive and suitable spot about the harbor could not have been chosen. In the rear of the village Salt Pond Hill rises abruptly to a height of one thousand feet or more, and upon its highest point are the ruins of an old stone fort known as "Rodney's Lookout." From this position a glorious view of the surrounding country is obtained. Here, in the early days of pirates and buccaneers, Admiral Rodney had his stronghold, whence he could look out upon the harbor and sea and detect the approach of enemies.

From the veranda of our laboratory we had a grand view of Kingston Harbor, in which the entire fleet of the English navy might anchor with safety. Following the low, sandy beach to the left we see the fishermen's hamlets and old Port Augusta. Across the harbor the city of Kingston appears in dim outline; and off to the right, upon the end of the "pallisadoes" protecting the harbor, lies old Port Royal, which was nearly destroyed by the earthquake of 1692. To the southeast the harbor opened out into the deep waters of the Caribbean Sea. The beautiful landscape stretching out thus before us was completed by the Blue Mountains, which formed a dark gray background. The highest point of the range is Blue Mountain Peak (7,560 feet). It appears in bold relief above the range, twelve miles east of Kingston. Two years ago some of our party made the ascent of the mountain. They encamped on the peak overnight, and enjoyed the rare luxury of soft beds of tree-fern leaves improvised for the occasion. The location of our laboratory offered many facilities for biological research. Numerous coral reefs, mangrove swamps, and salt ponds were all within an hour's sail from our port. Good opportunity for study is also found on land. The hills in the rear and the broad valley of the Rio Cobre, not far away, are stocked with land crabs, lizards, termites, scorpions, and the like. Bird life is not so abundant as we had anticipated, but to a botanist the flora of Jamaica offers a most attractive field for study.

By those who are acquainted with the coast of Jamaica, Port Henderson is thought to be the most suitable location on the island for a permanent marine laboratory. It offers many advantages for study of life in tropical waters; its collecting grounds and its facilities for "towing" and "dredging" are next in value to those of the Gulf Stream. The location is in the immediate vicinity of Kingston, whence the temporary wants of the party may be readily supplied. It is also in direct communication with New York and Liverpool by steamer and cable. With a view, then, of locating a permanent laboratory for promoting the study of marine biology, a plan is at present being considered by promi-

Fig. 2.—In Kingston Harbor.

nent biologists at home and abroad for establishing an "International Marine Biological Station" at the place above named. It is sincerely hoped that the preliminary steps taken in this direction may lead to the establishment of the much-needed institution on American shores.

The building which we called our "Marine Laboratory" was a large, one-story stone structure, known as the "Sister Houses." It was light, airy, and comfortable, affording ample room for our party of seven. Each member of the company occupied a separate table, and upon this his microscope was placed, together with a varied collection of specimens, "preserving" fluids, dishes, scalpels, etc., the whole forming a veritable "biologist's corner." In other parts of the building were our nets, buckets, jars, gun, and dredge, also books and chemical reagents, arranged as occasion and space suggested.

Our usual programme for the day began with early coffee and toast; then we repaired to our sloop with nets, water glass, dredge, etc., and rowed out to the coral reefs or so-called cays. Landing on one of these, we waded about in water, varying in depth from tiny waves that rippled over the sandy beach to breakers whose white crests dashed over our shoulders, and filled our faces with salty spray. After collecting for two or three hours we would sail for port. One rule adopted for these expeditions shows the ease and freedom existing among the members of our party—i. e., "No one is allowed to capsize the boat more than three times; more than this is considered dangerous on account of sharks." The regulation was closely observed. When the laboratory was reached, the morning's collection was set aside for an hour, while all prepared for breakfast by taking a plunge into a large swimming pool near by. Our meals were served after the English custom prevailing on the island, and were characterized by a large variety of tropical fruits and vegetables. The Ripley pineapples, No. 11 mangoes, and sapodillas were luscious fruits, but quite forgotten when we returned to the States and found American melons and peaches. After breakfast the remainder of the day was generally devoted to the study and preservation of the morning's collection. After a lunch of fruits and limeade we frequently took walks over Salt Pond Hill or up the valley of the Rio Cobre, in search of termites, scorpions, centipeds, and lizards. Late in the evening was the best time for "towing," although we often went out early in the morning. To do surface collecting we would row out upon the quiet bay about a mile from shore, then throw out two nets made of fine silk bolting cloth. These were tied by long cords to the stern of the boat, so as to drag near the surface of the water. The nets were carefully emptied into buckets of fresh sea water every few minutes. The "tow," or material

thus captured, was taken directly to the laboratory and examined. By dipping out small portions in glass dishes and holding them up to the light we could detect a great number of minute pelagic animals swimming about in great commotion. These "surface collections" are intensely interesting, for in them the biologist finds multitudes of embryonic forms in various stages of their development. The larvæ of starfish, sea urchins, shrimps, conchs, and other forms, appear in their normal living state under his lens. Besides larvæ, numerous adult forms, as *Sagitta*, *Appendicularia*, platoid worms, *Medusæ*, and green *Algæ*, are collected. A careful survey of the hosts of forms thus captured, and a fair understanding of their true significance, prepare one for the often-repeated statement that "the ocean is the original home of all life." We are impressed with the fact that it is from this source that we must seek further information that shall throw light upon many biological problems at present unsolved. A few days of general collecting in the sea suffices to reveal the great abundance of life in the ocean as compared with its scarcity on land.

The various expeditions taken by our party in the tropics would have been interesting and enjoyable to almost any one. To the casual observer they may have presented the appearance of pleasure excursions, rather than trips for earnest work and study.

On one occasion we sailed to Salt Pond, a kind of lagoon bordering the sea, where numbers of crocodile and turtle were frequently found. We had been rowing about for some time in the pond with no success except that of catching mullet with a throw-net, and taking note of the numerous cranes, pelicans, and bitterns flying about, when we came upon a "crocodile slide." This is a smooth, broad trail leading up the bank, which the beast follows when it wishes to prepare a nest in the sand for its eggs, or take a ramble beneath the underbrush.

No sooner had we neared the slide than here came a frightened crocodile about seven feet in length, dragging himself down the slippery bank into the water. As it swam out in front of our boat, its black nose protruded above the surface, offering a fine shot, but fortunately for the crocodile our gun was left at home.

Before leaving the pond we secured a fine collection of large, beautiful jellyfish (*Cassiopea*), and luckily for us the boatman discovered a dozen or more little crocodiles among the mangrove roots; we all repaired to the scene, and amid much excitement succeeded finally in capturing one.

One of the most productive collecting fields for our studies was that in the mangrove ponds off the "pallisadoes," near Port Royal. The mangroves in this region have extended into the shoal water,

thus forming a number of quiet ponds and canals. We found life very abundant here. Upon the mangrove roots great clusters of *Clavelina*, simple ascidians, and colonies of hydroids hung near the surface of the water. Battery actinians and *Botryllus* grew in the warm waters, attached to blades of eel grass. Echinoderms were very abundant. Sea urchins (*Strongylocentrotus*) were thickly strewn over the bottoms of the ponds. Of starfish we collected three forms (*Echinaster*, *Asteropectin*, and *Astorina*). For holothurians no other place along the coast was better. They were profusely scattered about over the muddy bottoms of the ponds. Some were dark brown, others large and spotted, growing to a length of eight and ten inches. Our experience in collecting and preserving these large holothurians was always exasperating, for,

FIG. 3.—THE MARINE LABORATORY.

try any experiment we might, they would always end with negative results. About the time we considered them fully narcotized they began contracting the muscles of the body walls, then suddenly eviscerated themselves. One very interesting form (*Synapta vivipara*) was found in great numbers growing among the filaments of a certain alga in the ponds. Sponges, gasteropods, and annelids were also numerous about the mangroves.

Taking the animals alive to the laboratory was an important part of our expeditions. For this purpose we used water buckets and open jars. The various specimens were distributed in different vessels, so as not to be crowded; these were allowed as much fresh sea water as possible, which was changed repeatedly.

Fig. 4.—Mangroves and Native Fishing Boat.

Of all our excursions during the season, those of most popular interest were to the cays which were out in the Caribbean Sea, two to ten miles from our laboratory. They may be described as small islets jutting above the waves a few feet. Some were covered with mangrove bushes, others were of bare rock and sand, over which large waves would break. By overturning stones in the shallow water we found many interesting animals. Brittle stars and sea baskets often shared their homes with spiny annalids and coiling synaptas. Darting about among the rocks were little rock crabs, young lobsters, and small shrimps. Beautiful sea anemones and turbellarian worms were numerous upon the rocks. Wading out a few steps into the deeper water we came to rich coral formations; and looking through a water glass we could see as through an open window into these beautiful gardens under the sea. There were massive brain corals (*Meandrina*) growing in scattered groups, with other interesting species between; clusters of star corals (*Astræa*) and branching stag-horns (*Oculina*) covered large areas. In the clear, open spaces were exquisite sea fans and sea feathers (*Alcyonaria*) waving their graceful forms to and fro with the tide. The scene was made even more charming when schools of beautifully colored coral fish, goldfish, and mullet swam in and out among the corals and into the open sea. A poet has seen these quiet parlors of the fishes and thus described them:

"There with a light and easy motion
The fan-coral sweeps through the clear deep sea,
And the yellow and scarlet tufts of ocean
Are bending like corn on the upland lea,
And life in rare and beautiful forms
Is sporting amid those bowers of stone;
Where the purple mullet and goldfish rove,
Where the waters murmur tranquilly,
Through the bending twigs of the coral grove."

Any report of the Johns Hopkins Marine Laboratory in Jamaica would be incomplete without mention of the kind hospitality shown us by the citizens. Our party was cordially received wherever it went; and at the laboratory we were honored by calls from chief officials residing in Spanish Town, Kingston, and Port Royal. As a body of American students, we had the pleasure of taking lunch at "The King's House" with Lady Blake, the governor's wife. It was very gratifying to find the prominent citizens of Jamaica enthusiastic in their encouragement of biological research on the island.

As to the results of the summer's work in the tropics, little can be said at present that is final, since much of it is not yet completed. A good quantity of valuable material was pre-

served for future study. Very full notes and drawings of the animals in their living and normal condition were made. These notes and drawings, together with the alcoholic specimens, are stowed away awaiting further investigation, to be carried on chiefly at the Johns Hopkins University.

THE RELATION OF EVOLUTION TO POLITICAL ECONOMY.

BY CHARLES S. ASHLEY.

IF the reader will call to mind the great work of John Stuart Mill, which still contains the best exposition extant of the whole subject of political economy, he will remember that Mill considers it by an analysis of production, distribution, and exchange, to which he adds a book on the influence of the progress of society on production and distribution, and another on the influence of government.

The first three books are devoted, as Mill himself says, to an examination of the "statics" of the subject. They are an analysis of the phenomena mentioned as exhibited at a given time; or, more accurately speaking, Mill's work is really an analysis of the manner in which products are distributed throughout society under a single set of social conditions.

To an evolutionist accustomed to seeing in industrial society an organism which grows and changes like all others, Mill's omissions, including those of his fourth book, are more striking than his inclusions. There is, indeed, a bare mention of the fact that the progress of society is accompanied by increased security and co-operation. But the evolutionary conception that industrial society, like all other organisms, begins with a simple germlike state and by constant changes increases its structures and its functions, nowhere occurs. Political economy is considered without material reference to *time* or *environment*. And it is treated as if industrial society were only to be considered with reference to the way in which social sustenance, however obtained, is distributed along the social alimentary canal. Processes of production, changes in methods caused by inventions, and changes of conditions are ignored, and the formation of industrial organizations of men engaged in common works, corresponding to organic structures, is passed by. Included in this is the all-important subject of the division of labor, the examination of the conditions under which it takes place, and the like. Strange as it may seem to one who looks on industrial society from a standpoint of facts rather than books, the functions performed by railroads, by banks, by

boards of trade, and by telegraphs, without which existing society would instantly dissolve, are nowhere set forth. And likewise the great subject of industrial disorders, their origins, progress, and decline, a subject which promises so much to scientific study, is not even hinted at. In a word, the conception of industrial society as an organism, subject to the same laws of evolution as others, and like other organisms having its structures and functions, its changes in response to environment, its health and disease, is entirely absent.

It is the province of evolution to introduce these ideas into political economy; to point out the harmony of the evolution of industrial society with that of universal Nature. Evolutionary political economy begins with the formation of those simple social groups whose members lived by hunting and fishing, and the first step in industrial life is shown to be the selection of a member surpassing the rest as a maker of weapons and implements for that duty. This step increases the strength of the group and leads to a further increase in size. Presently, by the interaction of this and other factors, the size of the group becomes such that it is partly encouraged, partly forced into the pastoral and then into the agricultural state.

And, however blended and complicated with other social phenomena industrial evolution may be, no one who has once fixed his eye on the cardinal principles of evolution will fail to see how strikingly they reveal themselves in economic history. As the yolk slowly divides and again divides until head and limbs and stomach and feathers faintly appear, and finally the chick steps forth, so industrial society, impelled by an indwelling force, evolves from time to time as conditions permit the organizations of men necessary for the better supply of social wants, and also the functions they perform and the processes by which they work.

To me the supreme lesson evolution has to offer to students of political economy is the automatic and irresistible nature of the process by which society evolves the functions and structures needful for its betterment. No philosopher or statesman invented boards of trade or foresaw their indispensable necessity as the social agents for the distribution of grain throughout the world, for the steadying of prices, and for the guaranty they afford of a close approximation of the prices paid the producer to that paid by the consumer. No economist established banks or conceived the vast uses they would subserve. No human mind foresaw the uses of the railroad, the steamboat, or the telegraph, nor were any of these created with much thought as to such uses. Gunpowder had accomplished its mission of establishing the physical supremacy of intelligence before anybody understood what that

mission was. The same may be said of the alphabet and printing. If one reads the vivid account Lord Macaulay gives of the founding of the Bank of England, of the debates thereon, and the still more violent debates on the usefulness or danger of the goldsmiths who originated banking, he will get a good illustration of the utter unconsciousness with which social improvements are made, and the universality with which they arise from a desire for the attainment of some immediate individual end. The great financial invention of our own day—building and loan associations—has begun in the desire of wage-earners, who never heard of Mill, or Spencer, or Das Kapital, to get homes for themselves and each other, and has been perfected in humble and unknown hands till now, having built a million homes, earned a high rate of interest for millions of members, they have grown to hold more money than the savings banks, and may at length aspire to engage the notice of Chauncey M. Depew when next he tells the public what to do with a thousand dollars of savings. Industrial improvements unfold as silently and modestly as the leaf on the tree. New structures, for new uses, do not spring from old structures, fixed in other uses, but from the undeveloped part of the organism, and gradually by inconsidered increments the mightiest economic changes are made. These characteristics of social evolution give us greater faith in the natural progress of society, and have a most important and decisive bearing upon many of the questions agitating social philosophers so much and the rest of the world so little.

Evolution teaches us to expect further changes to be additions to the present state rather than anything like subversions. There will be a continual increase in division of labor, increased social stability, and we may expect increased industrial co-operation by means of market reports, by which production in the various trades will be kept more perfectly equilibrated than at present, and the overproduction of any one product prevented. All labor will become more and more specialized, and unskilled labor will have a continual tendency to disappear.

Perhaps the most important and interesting topic that evolution brings into political economy is the vast subject of industrial disorders. That these are capable of scientific treatment no evolutionist will deny, because they are essentially like all other ills of humankind. What are industrial disorders? How do they originate? What course do they run? How and when do they subside? Evolution can and will treat these great questions in a comprehensive way, and when it does we shall for the first time have clear ideas on the most engrossing subject of our own day. That evolution has a panacea to offer I do not believe, for it reminds us at every turn that pain and suffering are an inseparable

accompaniment of organic growth and development. But it will at least teach us not to aggravate social ills by quack nostrums interfering with Nature's laws.

Finally, evolution will rescue political economy from the mist of words and disputation which now surrounds it by reason of the narrow basis on which it has rested. It will bring us back from the uncertainties of analysis and inference from insufficient data to the clear light of universal history—to the experience of great Nature's self, and will for the first time raise political economy from empiricism to science.

PHYSICAL CONDITIONS OF THE DEEP SEA.*

By SIDNEY J. HICKSON, M. A., D. Sc.

IT is not surprising that the naturalists of the early part of the present century could not believe in the existence of a fauna at the bottom of the deep seas. The extraordinary conditions of such a region—the enormous pressure, the absolute darkness, the probable absence of any vegetable life from want of direct sunlight—might very well have been considered sufficient to form an impassable barrier to the animals migrating from the shallow waters and to prevent the development of a fauna peculiarly its own.

The fragmentary accounts of animals brought up by sounding lines from great depths might, it is true, have thrown doubts on the current views; but they were not of sufficient importance in themselves, nor were the observations made with such regard to the possibility of error, as to withstand the critical remarks that were made to explain them away.

The absence of any evidence obtained by accurate systematic research, together with the consideration of the physical character of the ocean bed, were quite sufficient to lead scientific men of that period to doubt the existence of any animal life in water deeper than a few hundred fathoms. We now know, however, that there is a very considerable fauna at enormous depths in all the great oceans, and we have acquired, moreover, considerable information concerning some of those peculiar physical conditions of the abyss that fifty years ago were merely matters of speculation among scientific men.

The relation between animals and their environment is now a question of such great interest and importance that it is necessary

* Abridged from The Fauna of the Deep Sea. By Sidney J. Hickson, M. A., D. Sc. Modern Science Series. In press of D. Appleton & Co.

in any description of the fauna of a particular region to consider its physical conditions and the influence that it may be supposed to have had in producing the characteristics of the fauna.

The peculiar physical conditions of the deep seas may be briefly stated to be these: It is absolutely dark so far as actual sunlight is concerned, the temperature is only a few degrees above freezing point, the pressure is enormous, there is little or no movement of the water, the bottom is composed of a uniform fine soft mud, and there is no plant life. All of these physical conditions we can appreciate except the enormous pressure. Absolute darkness we know, the temperature of the deep seas is not an extraordinary one, the absence of movement in the water and the fine soft mud are conditions that we can readily appreciate; but the pressure is far greater than anything we can realize. At a depth of twenty-five hundred fathoms the pressure is, roughly speaking, two and a half tons per square inch—that is to say, several times greater than the pressure exerted by the steam upon the piston of our most powerful engines. Or, to put the matter in other words, the pressure per square inch upon the body of every animal that lives at the bottom of the Atlantic Ocean is about twenty-five times greater than the pressure that will drive a railway train.

A most beautiful experiment to illustrate the enormous force of this pressure was made during the voyage of H. M. S. Challenger. I give the description of it in the words of the late Prof. Moseley: "Mr. Buchanan hermetically sealed up at both ends a thick glass tube full of air, several inches in length. He wrapped this sealed tube in flannel, and placed it, so wrapped up, in a wide copper tube, which was one of those used to protect the deep-sea thermometers when sent down with the sounding apparatus. This copper tube was closed by a lid fitting loosely, and with holes in it, and the copper bottom of the tube similarly had holes bored through it. The water thus had free access to the interior of the tube when it was lowered into the sea, and the tube was necessarily constructed with that object in view, in order that in its ordinary use the water should freely reach the contained thermometer.

"The copper case containing the sealed glass tube was sent down to a depth of two thousand fathoms and drawn up again. It was then found that the copper wall of the case was bulged and bent inward opposite the place where the glass tube lay, just as if it had been crumpled inward by being violently squeezed. The glass tube itself, within its flannel wrapper, was found, when withdrawn, reduced to a fine powder, like snow almost. What had happened was that the sealed glass tube, when sinking to gradually increasing depths, had held out long against the pressure, but this at last had become too great for the glass to sustain,

and the tube had suddenly given way and been crushed by the violence of the action to a fine powder. So violent and rapid had been the collapse that the water had not had time to rush in by means of the holes at both ends of the copper cylinder and thus fill the empty space left behind by the collapse of the glass tube, but had instead crushed in the copper wall and brought equilibrium in that manner. The process is exactly the reverse of an explosion, and is termed by Sir Wyville Thomson an 'implosion.'"

It is only reasonable to suppose that the ability to sustain this enormous pressure can only be acquired by animals after generations of gradual migrations from shallow waters. Those forms that are brought up by the dredge from the depths of the ocean are usually killed and distorted by the enormous and rapid diminution of pressure in their journey to the surface, and it is extremely probable that shallow-water forms would be similarly killed and crushed out of shape were they suddenly plunged into very deep water. The fish that live at these enormous depths are, in consequence of the enormous pressure, liable to a curious form

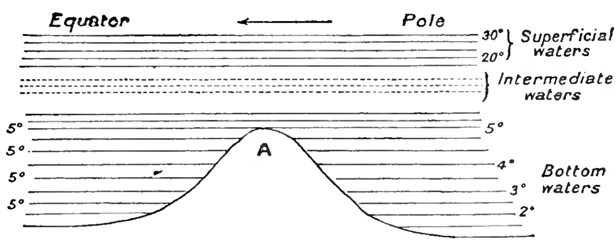

Fig. 1.—Diagram illustrating the Passage of an Ocean Current across a Barrier (A).

of accident. If, in chasing their prey or for any other reason, they rise to a considerable distance above the floor of the ocean, the gases of their swimming bladder become considerably expanded and their specific gravity very greatly reduced. Up to a certain limit the muscles of their bodies can counteract the tendency to float upward and enable the fish to regain its proper sphere of life at the bottom; but beyond that limit the muscles are not strong enough to drive the body downward, and the fish, becoming more and more distended as it goes, is gradually killed on its long and involuntary journey to the surface of the sea. The deep-sea fish, then, are exposed to a danger that no other animals in this world are subject to—namely, that of tumbling upward. That such accidents do occasionally occur is evidenced by the fact that some fish, which are now known to be true deep-sea forms, were discovered dead and floating on the surface of the ocean long before our modern investigations were commenced.

Until quite recently, every one agreed that no rays of sunlight could possibly penetrate the sea to a greater depth than a few

hundred fathoms. Moseley says that "probably all is dark below two hundred fathoms excepting in so far as light is given out by phosphorescent animals," and Wyville Thomson speaks of the "utter darkness of the deep-sea bottom."

Within the last few years a few authors have maintained that it is quite possible that a few rays of sunlight do penetrate even to the greatest depths of the ocean—a view mainly based on the fact that so many deep-sea animals possess extremely perfect and complicated eyes and very brilliant colors. Verrill says: "It seems to me probable that more or less sunlight does actually penetrate to the greatest depths of the ocean, in the form of a soft sea-green light, perhaps at two or three thousand fathoms equal in intensity to our partially moonlight nights, and possibly at the greatest depths equal only to starlight. It must be remembered that in the deep sea far away from land the water is far more transparent than near the coast." Packard is of a similar opinion.

There seem to me to be very slight grounds for this view. The fact that, comparatively speaking, shallow-water fish avoid nets that are rendered phosphorescent by entangled jellyfish does not justify us in assuming that deep-sea fish avoid regions where there are phosphorescent Gorgonians or Pennatulids. It is not by any means certain that fish avoid sunken nets on account of their phosphorescence. Most fish possess, as is well known, a very acute sense of smell, and it is very probable that they avoid such nets on account of the putrid odors of the dead animals that remain attached to them.

Nor is there much strength in the further argument that it can hardly be possible that there can be an amount of phosphorescent light regularly evolved by the few deep-sea animals, having this power, sufficient to cause any general illumination, or powerful enough to have influenced, over the whole ocean, the evolution of complex eyes, brilliant and complex protective colors, and complex commensal adaptations.

We have no sound information to go upon to be able to judge of the amount of light given off by phosphorescent animals at the bottom of the deep sea. The faint light they show on deck after their long journey from the depths in which they live to the surface may be extremely small compared with the light they give in their natural home under a pressure of two tons and a half to the square inch. The complex eyes that many deep-sea animals exhibit were almost certainly not evolved as such, but are simple modifications of eyes possessed by a shallow-water ancestry.

The more recent experiments that have been made tend to show that no sunlight whatever penetrates to a greater depth, to take an extreme limit, than five hundred fathoms. Fol and Sarasin, experimenting with very sensitive bromo-gelatin plates, found

that there was no reaction after ten minutes' exposure at a depth of four hundred metres on a sunny day in March. But although it is very highly probable that not a glimmer of sunlight ever penetrates to the depths of the ocean, there is in some places, undoubtedly, a very considerable illumination due to the phosphorescence of the inhabitants of the deep waters.

All the Alcyonarians are, according to Moseley, brilliantly phosphorescent when brought to the surface. Many deep-sea fish possess phosphorescent organs, and it is quite possible that many of the deep-sea protozoa, tunicates, jellyfish, and crustacea are in their native haunts capable of giving out a very considerable amount of phosphorescent light. If we may be allowed to compare the light of abysmal animals with that of surface forms, we can readily imagine that some regions of the sea may be as brightly illuminated as a European street is at night—an illumination with many very bright centers and many dark shadows, but quite sufficient for a vertebrate eye to distinguish readily and at a considerable distance both form and color.

To give an example of the extent to which the illumination due to phosphorescent organisms may reach, I may quote a passage from the writings of the late Sir Wyville Thomson: "After leaving the Cape Verd Islands the sea was a perfect blaze of phosphorescence. There was no moon, and although the night was perfectly clear and the stars shone brightly, the luster of the heavens was fairly eclipsed by that of the sea. It was easy to read the smallest print, sitting at the after-port in my cabin, and the bows shed on either side rapidly widening wedges of radiance so vivid as to throw the sails and rigging into distinct lights and shadows."

A very similar sight may frequently be seen in the Banda seas, where on calm nights the whole surface of the ocean seems to be a sheet of milky fire. The light is not only to be seen where the crests of waves are breaking, or the surface disturbed by the bows of the boat, but the phosphorescence extends as far as the eye can reach in all directions. It is impossible, of course, to say with any degree of certainty whether phosphorescence such as this exists at the bottom of the deep sea, but it is quite probable that it does in some places, and hence the well-developed eyes and brilliant colors of some of the deep-sea animals. On the other hand, the entire absence or rudimentary condition of the eyes of a very considerable proportion of deep-sea animals seems to prove that the phosphorescent illumination is not universally distributed, and that there must be some regions in which the darkness is so absolute that it can only be compared with the darkness of the great caves.

It may be stated then with some confidence that in the abysmal

depths of the ocean there is no trace of sunlight. It is highly improbable, on the face of it, that any ray of light could penetrate through a stratum of water four miles in thickness, even if the water were perfectly pure and clear, but when we remember that the upper regions, at least, are crowded with pelagic organisms provided with skeletons of lime and silica, we may justly consider that it is impossible.

The temperature of the water in the abyss is by no means constant for a constant depth, nor does it vary with the latitude. It is true that, as a rule, the water is colder at greater depths than in shallower ones, and that the deeper the thermometer is lowered into the sea, the lower the mercury sinks. This is consistent with physical laws. If there is any difference at all in the temperature of a column of water that has had time to settle, the thermometer will always reach its highest point at the top of the column and its lowest at the bottom, for the colder particles being of greater specific gravity than the warmer ones will sink, and the warmer ones will rise. The truth of this will be clear if we imagine a locality at the bottom of a deep ocean with a source of great heat such as an active volcano.

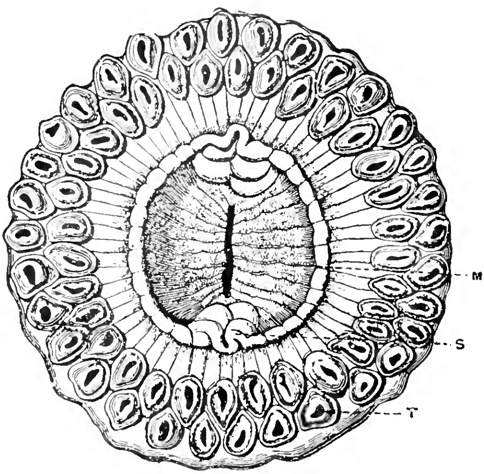

Fig. 2.—Sicyonis crassa: M, mouth; S, ciliated groove; T, tentacles. Each tentacle is perforated by a single large aperture. (After Hertwig.)

Such a source of heat would, it is true, raise the temperature of the water in its immediate vicinity, but the particles of water thus heated would immediately commence to rise through the superjacent layers of colder water, and colder particles would fall to take their places. Thus the effect of an active volcano at the bottom of the deep sea would not be apparent at any very great distance in the same plane. In fact, unless the bottom of the ocean was closely studded with volcanoes we should expect to find, as indeed we do find, that the temperature of the sea rises as the water shallows.

If then we were to consider a great ocean as simply a huge basin of water, we should expect to find the water at the surface warmer than the water at the bottom. The temperature of the surface would vary constantly with the temperature of the air

above it. That is to say, it would be warmer at the equator than in the temperate regions. The temperature at the bottom would be the same as the lowest temperature of the basin, that is, of the earth that supports it. The great oceans, however, can not be regarded as simple basins of water such as this. The temperature of the surface water varies only approximately with the latitude. It is, generally speaking, hottest at the equator and coldest at the poles, but surface currents in the intermediate regions produce many irregularities in the surface temperature.

Again, although we have no means of knowing what the temperature of the earth is at one thousand fathoms below the surface of the ocean, it is very probable that in the great oceans the temperature of the deepest stratum of water is considerably lower than the true earth temperature. This is due to currents of cold water constantly flowing from the poles toward the equator. If these polar currents were at any time to cease, the temperature of the lowest strata of water would rise. Although the polar currents can not be actually demonstrated nor their exact rapidity be accurately determined, the deduction from the known facts of physical geography that they do actually exist is perfectly sound and beyond dispute. A few considerations will, I think, make this clear.

If the ocean were a simple basin somewhat deeper at the equator than at the poles, the cold water at the poles would gradually sink down the slopes of the basin toward the latitude of the equator, and the bottom temperature of the water would be constant all the world over. A few hills here and there would not affect the general statement that for a constant depth the temperature of the lowest stratum of water would be constant. But in some places ridges occur stretching across the ocean from continent to continent, and these ridges shut off the cold water at the bottom of the sea on the polar side from reaching the bottom of the sea on the equator side. If A (Fig. 1) represents a ridge stretching from continent to continent across an ocean, and the arrow represents the direction of the current, then the water that flows across the ridge from the polar side to the equator side will be drawn from the layers of water lying above the level of the ridge, and consequently none of the coldest water will ever get across it, and from the level of the ridge to the bottom of the sea on the equatorial side the water will have the same temperature as the water at the level of the ridge on the polar side. It follows from this that in places where there are deep holes in the bed of the ocean surrounded on all sides by considerable elevations, the temperature of the water at the bottom will be the same as the temperature of the water on the summit of the lowest ridges that surrounds them.

This explains why it is that we find that the bottom temperature for a given depth is frequently less in one place than it is in

another, even in places of the same parallel of latitude. One or two examples may be taken to illustrate these points. The temperature off Rio Janeiro in latitude 20° south was found by the Challenger to be 0·6° C. at a depth of 2,150 fathoms. In a similar latitude north of the equator at a depth of 2,900 fathoms the temperature was found to be 2·2° C., and at a point near Porto Rico there is a deep hole of 4,561 fathoms, with a bottom temperature of 2·2° C.

Again it has been shown by the American expedition that the temperature of the water at the deepest point in the Gulf of Mexico, 2,119 fathoms, is the same as that of the bottom of the Straits of Yucatan, 1,127 fathoms, namely, 4·1° C. And, passing to another part of the world altogether, we find in the small but deep sea that lies between the Philippines and Borneo that, at a depth of 2,550 fathoms, the temperature is 10·2° C. These facts then show that, although at the bottom of the deep seas the water is always very cold, the degree of coldness is by no means constant in the same latitude for the same depth.

We must now return to the polar currents. We have assumed above that these currents do exist, and it is probable that by this time the reader must have seen why they are assumed to exist. The water at the bottom of the ocean is exceedingly cold. Where does this coldness come from? It is obvious that in temperate and tropical climes it does not come from the surface. Nor is it at all probable that it comes from the earth upon which the water rests; for, if it were so, the temperature for water of a given depth would always be the same. We should not find the bottom temperature of 2·4° C. at 2,900 fathoms off Rio de la Plata and a temperature of 2·2° F. in 4,561 fathoms off Porto Rico.

In fact, the only hypothesis that can with any show of reason be put forward to account for the temperature of the bottom of the ocean is that which derives its coldness from the polar ice.

Perhaps it is of the nature of an assumption to say that there are no rapid currents and tides in the abysmal depths of the ocean, for we have no means of demonstrating or even of calculating the rate of flow of these waters. But it is a reasonable hypothesis and one that we may well use until the contrary is proved.

A fact of some importance that supports this hypothesis, as regards some parts of the ocean at least, is presented by the sea-anemones. Many of the shallow-water actinians are known to possess minute slits in the tentacles and disk, affording a free communication between the general body cavity or cœlenteron and the exterior. In many deep-sea forms the tentacles are considerably shorter and the apertures larger than they are in shallow-water forms. It is difficult to believe that such forms, perforated by, comparatively speaking, large holes, could manage to live in rapid-

ly flowing water, for if they did so they would soon be smothered by the fine mud that composes the floor of all the deep seas. In fact, anemones of the type presented by such forms as *Sicyonis crassa* are only fitted for existence in sluggish or still water.

Another character that must be taken into consideration is that presented by the floor of the great oceans. The floor of the ocean, if it were laid bare, would probably present a vast undulating plain of fine mud. Not a rock, not even a stone, would be visible for miles. The mud varies in different parts of the globe according to the depth, the proximity to land, the presence of neighboring volcanoes, or the mouths of great rivers.

The globigerina ooze is perhaps the best known of all the different deep-sea deposits. It was discovered and first described by the officers of the American Coast Survey in 1853. It is found in great abundance in the Atlantic Ocean in regions shallower than

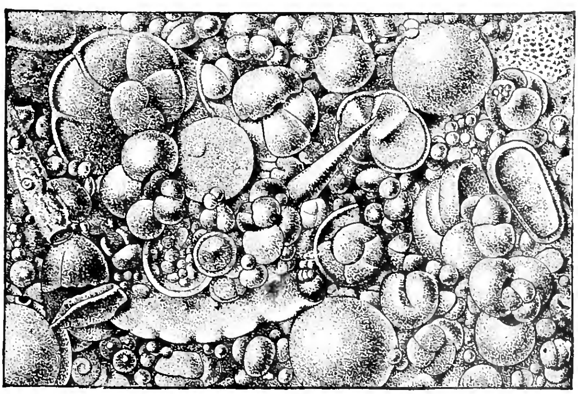

FIG. 3.—GLOBIGERINA OOZE. (After Agassiz.)

2,200 fathoms. Deeper than this it gradually merges into the "red mud." It is mainly composed of the shells of foraminifera, and of these the different species of globigerina are the most abundant. It is probably formed partly by the shells of the dead foraminifera that actually live on the bottom of the ocean and partly by the shells of those that live near the surface or in intermediate depths and fall to the bottom when their lives are done. So abundant are the shells of these protozoa that nearly ninety-five per cent of the globigerina ooze is composed of carbonate of lime. The remaining five per cent. is composed of sulphate and phosphate of lime, carbonate of ammonia, the oxides of iron and manganese, and argillaceous matters. The oxides of iron and manganese are probably of meteoric origin; the argillaceous matter may be due to the trituration of lumps of pumice stone and to the deposits caused by dust storms.

Globigerina ooze may be found on the floor of the ocean at

depths ranging from 500 to 2,800 fathoms of water in equatorial and temperate latitudes. The reason that it is not found in arctic seas may be that the cold surface waters of these regions do not bear such an abundant fauna of foraminifera. This is supported by the fact that it extends ten degrees farther north than south in the Atlantic, the warm water of the Gulf Stream bearing a richer fauna than the waters of a corresponding degree of latitude in the southern sea.

The pteropod ooze has only twenty-five per cent of carbonate of lime. It contains numerous shells of various pteropods, heteropods, and foraminifera, but nearly fifty per cent of its substance is composed of the siliceous skeletons of radiolaria and the frustules of diatoms. According to Murray, it is found in tropical and subtropical seas at depths of less than 1,500 fathoms.

The radiolarian ooze is found only in the deepest waters of the central and western Pacific Ocean. In some of the typical examples not a trace of carbonate of lime was to be found, but in somewhat shallower waters a few small fragments occurred. A diatom ooze, mainly composed of the skeletons of diatoms, has also been found in deep water near the Antarctic Circle, but it has not apparently a very wide range.

Of all the deep-sea deposits, however, the so-called "red mud" has by far the widest distribution. It is supposed to extend over one third of the earth's surface. It is essentially a deep-sea deposit, and one that is found in its typical condition at some considerable distance from continental land. Like the globigerina ooze it is never found in inclosed seas. To the touch it is plastic and greasy when fresh, but it soon hardens into solid masses. When examined with the microscope it is seen to be composed of extremely minute fragments, rarely exceeding 0·05 millimetre in diameter. It contains a large amount of free silica that is probably formed by the destruction of numerous siliceous skeletons, and a small proportion of silicate of alumina. It usually contains the remains of diatoms, radiolaria, and sponge spicules, and occasionally lumps of pumice stone, meteoric nodules, and, in colder regions, stones and other materials dropped by passing icebergs.

In the great oceans, then, we find in the deepest places red mud, or, where there is an abundant radiolarian surface fauna, radiolarian ooze; in water that is not deeper than about 2,000 fathoms, we find the globigerina ooze; in shallower waters and in some localities only pteropod ooze. It must not be supposed that sharp limits can anywhere be drawn between these different kinds of deposits, for they pass gradually into one another and present many intermediate forms.

It is probable that the sea water, by virtue of the free carbonic acid it contains in solution, is able to exert a solvent action upon

the calcium carbonate shells of animals as they sink to the bottom, and during the long and very slow journey from the surface to the bottom of the deepest seas these shells are completely dissolved. The first to be dissolved would be the thin, delicate shells of the pteropods and heteropods, for besides the fact that they present a wider surface to the solvent action of the water they are probably influenced more by tide and currents, sink more slowly and erratically, and thus have a longer journey to perform. Then the smaller but more solid and compact shells of the foraminifera are dissolved, and lastly, in the deepest water only the siliceous skeletons of the radiolaria and diatoms are able to reach their last resting place at the bottom of the ocean.

These four oozes then are characteristic of the floor of the deep oceans. In the proximity of land and in inland seas where deep water occurs, other muds are found differing from one another in accordance with the character of the coasts in their vicinity.

One more character of the deep-sea region must be referred to, and that is the absence of vegetable life. It has not been determined yet with any degree of accuracy where we are to place the limit of vegetable life, but it seems probable that below a hundred fathoms no organisms, excepting a few parasitic fungi, are to be found that can be included in the vegetable kingdom. While then the researches of recent times have proved beyond a doubt that there is no depth of the ocean that can be called azoic, they have but confirmed the perfectly just beliefs of the older naturalists that there is a limit where vegetable life becomes extinct. It is not difficult to see the reason for this. All plants, except a few parasites and saprophytes, are dependent upon the influence of direct sunlight, and as it has been shown above that the sunlight can not penetrate more than a few hundred fathoms of sea water, it is impossible for plants to live below that depth.

Noticing the proceedings of the recent meeting of the British Association at Nottingham, the London Spectator remarks upon "a singular deficiency in those careful descriptions of the precise position of any science which have so frequently wakened up ordinary men to careful thought." There is a popular side to the association's work which is not less important than the one by which it seeks to advance science. The aim of that side is "to arouse such general interest in science that the minds which are fitted for such study will be inclined to devote themselves to it. To obtain the ablest in any pursuit we need a vast reservoir of men who are more or less interested in it. You can not have your Napoleon of science without an army to draw him from, and the work of increasing the area of recruiting is not unworthy a great association. Of course, 'interesting papers' often add little to positive science; but then, neither do music and banners and fine uniforms add to military force. But they bring recruits, without which such force remains latent and useless."

HEREDITY IN RELATION TO EDUCATION.*

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IT is of course necessary that the education of a country shall be systemized, harmonized, and consolidated. This involves so much machinery, including examinations, inspections, reports, etc., that those concerned are under constant temptation to take the form for the substance, and to mistake the immediate issue for the great end. It will not be denied that this state of things exists or has existed in connection with every attempt to produce what has been termed a system of education. Manifestly system is essential to success. Without system, concerted plans, and co-operation you would not be here to-night. One of the great problems of the day is the extent to which system should prevail. The answer to this question, which is filled with practical issues, may be inferred, in part at least, from my treatment of education this evening.

The teacher has to do, in reality, primarily with methods, examinations, results, etc., only in so far as these are means to an end, that end being the development of human nature.

The teacher is, or should be, first, last, and always, a developer. If he sees no further than methods as set before him by others; if he assumes that the one method will suit all his pupils equally well; if he believes that there is any one invariably best method, he will become after all but a sort of machine. The educator is concerned with human nature, and must endeavor to study it in as broad a way as possible. To him the knowledge of the development of man from more primitive conditions is the study of all studies. His great aim should be to carry on in some measure this progress, this evolution or unfolding, for we know as yet but indifferently the possibilities for mankind.

Whether man was derived from some form of life lower in the scale or not, it is perfectly clear that he has passed through states not very distantly removed from the condition of the brutes, or, at all events, immeasurably remote from that of the civilized man of to-day. And the history of the race is in some measure the history of the individual. The teacher who does not realize this can scarcely understand the peculiar behavior of boys in particular. At times, especially when left to themselves, they seem to act like savages; for the moment they appear to revert to a savage state. But knowing the tendency of human nature to

* An address delivered before the Ontario Educational Association in Toronto, April, 1893.

right itself under favorable conditions, the teacher is considerate, hopeful, and wise in the guidance of his pupils.

But equally important is the study of the individual, and it is the neglect of this that constitutes perhaps the greatest danger of modern education. We adapt our methods to human nature as we conceive of it, but is the individual as much considered as he was? The tendency of the age is to aggregation of men, to concerted action, to adaptation of methods to the masses, to the average man or boy or girl, while John Smith and Eliza Brown are apt to be regarded as simply units and nothing more. If I were asked to state what I considered the greatest evil threatening education or actually existing in education, if not in our entire civilization to-day, I should reply that in my opinion it was just what I have referred to—not recognizing the individual as such in the masses.

Allow me to point out that the available energy of the world is increased in proportion as we develop individuals—i. e., human beings differing from their fellows. We see this in the passage of a community from a savage to a civilized condition. There is division of labor with differentiation of function. It is better for the community that there should be carpenters, blacksmiths, masons, etc., than that there should be an attempt to make each individual a Jack-of-all-trades. So in education we should aim to develop those differences that Nature has established. So-called education has done much harm by running counter to Nature. Evidently, then, the great business of the teacher is to study Nature with a solicitous anxiety to learn her meaning as to man.

Froebel, after ages of educational blundering by mankind, set out on the right path, because he, like the one who would enter the kingdom of heaven, became as a little child, and so understood children and adapted methods to human nature as it is—methods in which their individuality is recognized at the very outset. Would that we had followed this great genius closer; would that we were to-day applying his methods in their best aspects to our education more fully! I mean in the sense that we adapted our methods to human nature as it is, and not with any so-called practical end in view, such as fitting the boy or girl merely to sit at a desk in a warehouse, or stand behind a counter in a shop.

But our schools, like our other institutions, are a reflection of our general state of human progress; and while we have much to be thankful for, I must, with President Eliot, of Harvard University, consider that our school education is still in no small degree a failure, partly because we have not grasped the purpose of education and partly because we do not recognize that men are more than methods after all—that John Smith is more than

simply a human unit—that what suits him would not equally well suit Tom Jones.

Allow me to put the problem of education in a sort of combined biological and psychological form. It is impossible to conceive of any organism as existing apart from relations to other things that immediately or remotely affect it—in other words, its environment, which term will be used to designate the sum total of all those influences of whatsoever kind that are in any way related to or can affect such organism. Very often the most important factors in the environment are other organisms of the same kind, and this applies especially in the case of man.

In the discussion of educational problems it seems to be of vital importance to realize that we must consider man as a whole. Great mistakes have been made, and are being made, from regarding mind and body apart. As a matter of fact, we never know them apart. We have to do with that complex whole we call man. We only know the mind through the body, and speaking generally, so far as we can see, for every psychological manifestation there is a correlated or corresponding physical process. It is of importance not only to concede this in a theoretical way, but to be fully convinced of it; otherwise our education will labor under those misconceptions, irregularities, and inadequacies which have beset it in the past.

We get at the mind through the body. To one devoid of all sensation the world is as good as non-existent, and such an individual would be a mere vegetative organism incapable of any appreciable development. Apart from the senses there are probably no avenues to the mind for us. The dependence of the mind on the body in this broad way is then clear. It is not, however, very fully recognized yet that what hinders the development of the body or stands in the way of physical vigor or growth must be in a corresponding degree an impediment to the growth and development of the mind. Modern psychologists are more and more recognizing the mind as a growth and development; and undoubtedly when this great fact and the complete interdependence of mind and body are recognized we will be free from misconceptions that have fettered education of all kinds in the past.

The teacher who realizes this inevitable relation of mind and body can not be indifferent to the hygienic conditions and physical state of his pupils. The condition of the atmosphere of the schoolroom, the temperature, the quality and the direction of rays of light will be as much considered as the three R's, for in fact they are of vastly more importance in the development of the organism, as a whole, with which he is concerned.

Up to this point I have been endeavoring to show that the educator, in proportion as he has correct and comprehensive views

of human nature, is supposed to devise methods that accord with them. Even with such views he may not become a very successful teacher, because teaching is an art, and it is one thing to understand in the abstract and another thing to apply. But given the natural aptitude for the art, it is surely plain that the application will be more in harmony with our nature if that be understood. And in the application great skill will be required so that the individual will not be lost sight of. In fact, it is just here that the art of so many falls short. They lack the insight to recognize just what constitutes the individuality in each case and to adapt to this. I will therefore endeavor to assist in some measure in the solution of this problem by calling attention to a guide to the individual nature through the subject of heredity.

From the earliest times heredity, or the resemblance of offspring to parents, has been admitted in some vague way at least; and if this were now as clearly recognized for man as it is by breeders of our domestic animals, I would anticipate greater human progress than is likely till sound views on this subject are more widespread and more deeply impressed. How few have ever seriously sat down and pondered upon such questions as these: Why is my nature such as it is? To what degree am I and in what measure are ancestors concerned in my being what I am? What am I likely to become? I presume one might safely affirm that most persons here never directly faced such considerations at all. Probably many would regard it as impossible to account in any approximately satisfactory way for their physical and mental status, and would be very apt to refer the latter in no small degree to what is commonly known as education.

But if we were to visit the establishment of some successful breeder of domestic animals we would find no such hazy mental condition. The breeder does know why his stock is such as it is. You point to some admirable specimen and compare it with another of plainly inferior merit and ask him the reason why. He does not attempt to explain the difference by the pasture, but he tells you that the less valuable animal is a common cross-breed without extended pedigree, while the other is derived from ancestors that he can trace for generations, and the parents of which are now on his farm, the purchase price being a large one.

The breeder would have been greatly puzzled if such ancestors had produced offspring entirely unworthy of themselves. The same applies to the vegetable world. "Do men gather grapes of thorns or figs of thistles?" But apparently we often expect this rule to be reversed in regard to human beings. The fact is, man was so much regarded as a creature apart by himself with laws of his own—laws that were every now and then at least interfered with in some inexplicable way—that the public mind got demoralized;

for nothing can be so disastrous as to believe that the laws of Nature are subject to change. We may require to modify our views as to what the laws of Nature really are, but so far as the world has yet learned these laws are invariable.

I must confess myself to have had at one time almost unbounded faith in the changes that the environment could work, and especially that part of it that we call education, in the narrower sense. But a close study of the subject by observation and experiment in breeding some of our domestic animals for a term of years has very strongly impressed upon my mind the strength of heredity. Galton, Ribot, and others have given us the most convincing proofs that heredity is stronger than its antagonist variation or than its modifier environment. In accounting for variations—for no two beings are quite alike—we must admit great ignorance; however, it is impossible to ignore or disbelieve in the effect of the environment. We know that unless there be some favorable features in the environment the best nature can never develop.

The very same breeder we before visited might possibly be able to show us an animal that through accident, inadequate feeding, or other unfavorable condition in the environment had never proved worthy of its parentage, and the observer will meet many cases like this among human beings. They are instructive inasmuch as they illustrate the relative part played by heredity and environment in the total result. Galton, after most exhaustive and careful examination of large classes of men, as statesmen, judges, commanders, divines, authors, artists, and others, shows that of all those that attained great distinction a fair proportion left posterity worthy of them. He concludes also that if a man be possessed of really high-class native ability he will rise in spite of the environment, or, as Shakespeare has it, "Some men are born great."

But what of the mediocre? Do the same laws as to heredity and environment apply? The best way, in my opinion, to become convinced on this point is to make an honest and careful study of one's self. It sometimes takes years to realize the extent to which we represent, often in an occult manner, our ancestors; and we must remember that law, which Darwin has emphasized, that traits of ancestors tend to appear at the same period of life in the offspring as in the parents. It is further to be remembered that by a study of parents alone we can not get nearly so good an idea of the heredities of any individual as if more distant ancestors and collateral lines (uncle, cousins) be taken into account. Indeed, the believer in man's evolution from lower forms of life takes a much wider view of the whole subject.

It must be plain that each individual in some measure is the

resultant of all those forces represented in ancestors — forces which have been modified in innumerable ways by ancestors—a consideration which greatly complicates the study of heredity. But if any one principle has been established it is that heredity is stronger than environment. However, we must point out that the weaker the heredity the stronger the environment. Education, in the proper sense, can do more, relatively, for a mediocre or weak nature than for a very strong one. A real genius or a criminal will be such regardless of education; so that the practical issue for educators narrows down very much to the question of heredity and environment for the mediocre or submediocre. It is with the latter classes that the teachers of the land have mostly to do, though we must not overlook the possible best and wisest that may be intrusted to our care. Our systems are not well adapted to discovering them, especially those of high talent or genius, affairs so tend to averages and mediocrities in all directions these days.

It will now be my aim to indicate how the educator may, by a study of heredity in a practical, individual way, as well as heredity as a general fact in Nature, increase his usefulness by directing his energies to better advantage, from more exact knowledge of the individuals with whom he has to deal. However skilled the teacher may be in reading the individual from his conduct, the diagnosis (to borrow a medical term) will be much safer if we know the family history and the ancestral tendencies. It is so as regards disease—i. e., tendencies of the physical organization—and it is equally so with the mind, though not yet so generally recognized. The teacher who knows nothing of the parents of a child is but poorly prepared to do the best possible in developing that child.

With all the disadvantages associated with the career of a country school teacher who "boarded 'round" or was expected to make periodic visits, it can not be denied that he had opportunities for understanding that all-important home environment of his pupils, and of studying the parents and other relatives, and gathering hints from scraps of family history that greatly helped him who was not a believer that all children are to be treated educationally just alike, all minds to be compressed into the same mold.

With all its imperfections, I am bound to say that the individuality of the pupils in the old log schoolhouse was often more developed than in the city public school of to-day, where for a boy to be himself frequently brings with it the ridicule of his fellows—a condition of things that has its effect afterward on the lad at college. I find this fear of being considered odd—out of harmony with what others may think—one of the greatest draw-

backs to the development of independent investigating students at college. The case is still worse for the girls. When women begin to be really independent in thought, feeling, and action, I shall be much more hopeful of the progress of mankind; and happily the dawn of this better day has already begun.

It is scarcely necessary to point out that, in the nature of the case, the parents are in the best position to learn the hereditary tendencies of their children; but inasmuch as in the large proportion of cases the subject has never been given any serious attention by them, it remains with the teacher to work it out by such means as he can. As with the physician, practice makes perfect in observation, interrogation and diagnosis. Often a little conversation with the children when at their ease at home will give more information as to their real tendencies than weeks of observation at school. Parents frequently judge of the natural fitness of their own children for the various callings in life very badly; and the assistance of the skilled teacher in deciding such matters would be of inestimable value. By the skilled teacher I now mean the one who is an expert diagnostician of powers and especially of natural leanings in which heredity plays so very prominent a part. How often is the college teacher, who regards the mistake in the choice of a profession or career as fatal, pained when dealing with certain of his students who plainly should be somewhere else! Yet it is hard for him to tell a young man that he is out of place. This should all have been settled long ago.

In the course of some lectures on education given at the Johns Hopkins University several years ago, Dr. Stanley Hall, the eminent psychologist, drew attention to what he called a "life-book." In this a record as impartial as possible of such sayings and doings of each child of a family from infancy to adolescence as may be a guide to real tendencies is recommended to be kept. Teachers may widen their sphere of influence by making this recommendation according to discretion to at least some of the parents with whom they come in contact. Dr. Hall lays stress on recording the exact words of the child and on stating everything with extreme accuracy and impartiality, as the fond mother is very apt to put a flattering interpretation on sayings and doings and fail to record the indications of weakness or evil. It is interesting to paste in also the first letter, first story, first rude sketch, etc., indeed anything that will give a clew to the real nature of the child.

But, as before indicated, the teacher may discover in a visit to the home what may have escaped even the parents. I know myself of a born artist having been discovered in the very depth of poverty by a physician who was making a professional call.

That child has since developed into a distinguished man. Whether innate genius was sufficiently strong to have forced him through and above his environment apart from such early discovery and encouragement I can not say. At all events it would in all probability have been a case of devious ways, diverted energy, and lost time, if not final partial or complete failure, but for this early recognition.

No doubt the difficulties in the way of meeting all the parents in the case of a large class in the city school are considerable; and it may not be feasible to visit all, though much is gained in more ways than one by ascertaining the home environment as well as the heredities of the pupils. When once the teacher has made a somewhat complete and reliable estimate of the tendencies, good and bad, of any pupil and their relative strength, a large part of the problem of development is already solved.

Every human being may be regarded as an organism with a combination of qualities of varying strength, some of which, indeed most of which, are good in themselves but either weak or strong relatively to a common standard or with reference to each other, so that the question of balance is one of the most vital. The most dangerous of all members of society are those that are ill-balanced and lack self-control. The real criminal organization is of this nature. But so also is the faddist or extremist of any type dangerous, because being ill-balanced he himself tends to lead mediocre minds astray; and much energy that might be better employed must be used to counteract his dangerous doctrines and vigorous efforts.

The question with the teacher then is, How can I develop each nature committed to my charge so as to strengthen its weak parts physical, intellectual, and moral, so that no faculty shall be unduly developed and that the balance of the whole shall be good —while I do not overlook those faculties that are strong and on which the success of the individual so much depends? It can with the utmost confidence be assumed that in all human beings some powers are by inheritance of different strength from others. Some children are so weak in mathematical perception that they must receive careful and special attention to nurture this faculty up to an approach to the average, while at the same time it must not be made almost the sole standard of intellectual strength or excellence, as I fear has been too much the case in schools within the past twenty years, at all events. An intellect thus weak may have a good deal more than the average capacity for artistic or moral feeling, and men are not mere calculating machines but rather organisms, endowed with feelings that like the steam engine supply the source of power, the moving forces.

How sadly have we neglected the culture of right feeling in

our educational institutions! It was a natural consequence of the misleading because partial doctrine that the great purpose of the public school was to teach "the three R's." It can not be too much insisted on that the great purpose of all education is to furnish a favorable environment (using that term in the widest sense) for the development of the highest type of human beings consistent with the innate inherited tendencies. We can not make silk purses out of sows' lugs, but we must take care that we do not convert silk purses into lugs by our bungling and lack of insight, all the more likely if we place undue confidence in our educational systems which we call great because according to the tendencies of the day they affect vast numbers.

A study of heredity tends to prevent and mitigate discouragement, and it also shows us how great is the power of the organism to vary with changes of environment. In other words, education, in the true sense, can do much to modify. The world has passed from stages of almost bestial degradation to the present state of civilization through this tendency to vary under environment by some processes which we can appreciate and possibly by others that we do not fully understand. We have every reason to hope for the future; but this hope should be a rational one founded on the adaptation of means to an end, and in this the organisms must first of all be considered.

Regarding the human race in this light, it becomes clear to me that, after the parents themselves, the teacher may become the most potent factor in the development of the human being. He can not radically alter hereditary tendencies, but it is his great privilege to guide and modify them. In some cases he may require to steer so as to avoid Scylla and not fall into Charybdis; in others to develop energy in weak natures that only tend to drift along in life. But one thing is certain, that to attain these truly great results the teacher must himself be very much of a man; and the public would do well if it could but stop long enough in the race for wealth, power, or distinction to consider whether it is taking the right means to find and retain such people. Mankind must study and observe the laws of the heredities if the race is to make the greatest possible progress; and next to that the race must seek out and cherish in every way those that, after the parents themselves, have the greatest influence in molding and developing—the teachers of youth.

All other questions are subordinate. My colleagues in this noble work, let us in our day and generation realize our great opportunity and seize it.

THE CIRCASSIAN SLAVE IN TURKISH HAREMS.

By Mrs. ELLEN BATTELLE DIETRICK.

ONE of the curious anomalies of history is found in the existence of a race whose men are characterized by a passionate love of freedom, equaling that of a William Tell, but whose women habitually accept slavery as the most desirable of earthly conditions. No more thrilling story of spirited resistance to an invader can be found than that of the long struggle of Circassia against the persistently encroaching Slav. After forty years of continual warfare, overwhelmed by Russia's superior wealth and numbers, thousands of Circassians voluntarily chose expatriation rather than abide in their native land under the yoke of the conqueror, and deserted *en masse* the best part of the country, to take refuge in Turkey. Yet, from the time Circassia was first known to Europe, it has been the regular custom of these independence-loving, self-governing mountaineers to sell the sisters and daughters whose beauty has given chief fame to the name of Circassian; and, difficult as it may be for an American generation reared to abhor slavery to credit the statement, the testimony that these beautiful Circassians gladly accept, and even hasten to meet, their sale is too universal for doubt upon this point. The mystery, however, is largely solved when we learn that to the women of Circassia slavery and marriage are purely synonymous terms. To them slavery has meant an exchange from a laborious life of poverty in the mountains to that of ease and luxury as a wife—either chief or secondary—in a city harem. To the Turk, Circassian slavery has meant purchasing a wife to whom he need not give the name wife unless he choose (the sultans never thus distinguish any woman), and thus obtaining one or more companions who will, almost without doubt, be more obedient and contented in that capacity than any one he might secure from among the women of his own blood and rank in society. A Turkish woman of to-day writes: "Formerly a Turk rarely married his countrywoman; on the principle, I suppose, that 'exchange is no robbery,' he would marry a Circassian slave, and give his sister to a Circassian man slave, or to some penniless Circassian subaltern in the Turkish army. This was caused by the innate love of power existing in both sexes. A Turkish girl wedded to her equal would, by the laws of religion, feel herself obliged to treat her husband with nearly servile respect, while, when wedded to one so decidedly her inferior, she would be mistress in her own house, and, reigning supreme over her husband and slaves, would never fear a rival."

Far from dreading their sale, the girls of Circassia look for-

ward to it as the great opportunity of their lives. They go to seek it as a conscious jewel might start in search of a costly setting. They show no more reluctance than Esther manifested when Mordecai delivered her over as one of the fair young virgins gathered from far and near to adorn the palace of Ahasuerus. Indeed, the history of Esther reveals the motives which probably animate each of the many maidens of Circassia who to this day re-enact that old biblical story. Each believes that it is she who may find grace and favor in the royal crown, and thus control at will the rise or fall of the royal scepter. But even if not chosen by royalty, those who purchase the beautiful damsels of Circassia are the wealthy and titled; and not the slightest social degradation is attached to their position, even when taken to harems wherein a Turkish wife may be installed as head of the household. The common dependence of all the inmates of a harem upon the favor of a lord who may at any time elevate the Circassian slave to the position of a lady fosters a spirit of equality—of pure, practical democracy, that would be inconceivable under any other circumstances, and in our Southern slave relation to nominal mistress was totally undreamed of. As a Turkish lady explained to an astonished English visitor, "A slave may become a lady any day, and in treating her as one beforehand we take off very much of the awkwardness which would else ensue." When we consider that all the children of slaves are acknowledged as the legitimate children of their father, we must confess, in justice to the Turk, that theirs is a condition in which the evils of slavery to the slave are reduced to a minimum.

The first step after purchasing a Circassian girl is to give her (as unto Esther) a special retinue of personal slaves, brought from Africa, who relieve her henceforward of the slightest necessity of unpleasant exertion. Though she may not, like Esther, be put through "six months with oil of myrrh, and six months with sweet odors," every accessory of the toilet which may enhance her original attractiveness is bestowed upon her, accompanied by careful lessons in the graces of deportment. Thus to the mountain girl who looks forward to life in Turkey reports of that life go back freighted with all that could allure and blind the unthinking. Dread of an evil fate is reduced to a mere vague and flitting surmise, while the lottery matrimonial is represented to her as one filled with magnificent prizes. As the Circassians, though possessed of much native intelligence, have no written literature, none of these girls can read or write. They are trained for the marriage market as a fine horse is trained for a race course, and the higher price they bring the greater their satisfaction. "Ask a higher price for me, dear brother," says a Russian nobleman, "is their not uncommon admonition to the brother who is man-

aging the bargain." This affords a double gratification, that of being rarely valued for themselves, and of being most highly profitable to the family left behind in the mountains. Great was the astonishment of the first Russian crew which "rescued" a vessel-load of Circassians on their way to Turkey, to have the rescued ones entreat not to be returned to their homes, but to be forwarded to their destination. In spite of the combined efforts of Russian and English, their attempts at prohibition of slavery among the Turks have merely driven the trade into an appearance of secrecy here and there, without at all diminishing either demand or supply.

But a more effectual mode of changing human conditions is at work, silently and subtly undermining the whole system of slavery, polygamy, and concubinage in Turkey. Two remarkable letters, written by a Turkish inmate of a harem, appeared in the Nineteenth Century (of August and December, 1890), which give an interesting view of the transformation slowly fermenting in that last stronghold of extreme conservatism on the woman question—the seraglio. The writer, who signs herself "Adalet" (and who therein makes her first essay at writing), explains that the foreign education of Turkish boys inevitably paved the way for that of Turkish girls; that now sons and brothers are being educated at Oxford or in Paris, and have thus learned that "when her intellect is not crushed by continual fear and impotent ignorance, woman can become the helpmate and support of man"; that "the view also of the cheerful homes existent in Europe has taught them that one wife is better than twenty slaves; and as the Turkish girls are better adapted by nature to second their views than the Circassians, it is to them that they turned for help. It needed but little time to teach the Turkish mothers what was needed at their hands; and where before a little French was the maximum of learning acquired by a Turkish girl, she was now taught to read and write in several languages, to play the piano, to draw, to paint—in a word, to have as complete an education as any young lady destined to appear in society. This system, of course, included novel-reading; and in them the young girl, who before believed that the highest happiness for her was to be tyrannized over by a man she did not know, in common with five or six rivals, suddenly saw opened before her a long vista of unknown bliss, which, to her dazzled eyes, seemed more beautiful than anything promised in paradise. She heard of balls, *fêtes*, parties, where women spoke openly with men who were not doctors or cousins; she heard, for the first time, that a woman is considered as highly as a man, and may even claim from him the homage which, till now, she thought had been exclusively his prerogative; she saw in them the description of happy homes, where one wife alone

possessed the love and confidence of her husband, and little by little the poison imbibed circulated through her veins."

The writer continues, that as it is impossible for a reaction to occur in a country without its rushing to the opposite evil, in Turkey the leap from ignorance to knowledge had the first effect of so dazzling the Turkish woman that, in casting off the ancient trammels, she also in many cases abandoned the code of honor existent among women in every country. "Of our old customs, as well as of our old faith, very little remains, and it is only in the lower orders, or the most secluded harems, that some vestige of them can be found. At Constantinople women hardly hide their faces, and think it no shame to appear before the public in habiliments which would be hardly considered decent with the lowest dregs of European society."

But, as Adalet sagely observes, "All this is a secondary question." She rightly appreciates that freedom is a gift which can be wisely used only by practice in the use of freedom, and does not forsake her faith in freedom because its first possession has intoxicated those unaccustomed to it. Perceiving that slavery is the corner stone of polygamy, she urges that the women of Turkey should strive with all their force for the abolition of polygamy by themselves enfranchising their own slaves. But she also declares that, however good, as far as negroes are concerned, may be the result of the action of the English Government in Egypt for the enforced abolition of slavery, the effect upon the Circassians has been only evil, and that continually, and for these reasons: "No Circassian would ever condescend to go to the slave-home, or work as a servant. What has, then, been the result? Hundreds of white slaves have gone to the police court for their freedom, and from there have gone to the bad. In fact, they only took their papers with that intention, as no Circassian ever thought that slavery was a shame, or that it was irksome in any way. Freedom to them means nothing unless the freedom is accompanied by a husband and a home, and they know very well they can not expect these from the police court, as no marriage can be valid with the paper taken from there. . . . They have given a bad repute to the police court, and now no slave who respects herself will go there." Thus Adalet concludes: "I frankly own that I think, in the case of the Circassians, no efforts made for the abolishment of slavery will be successful, when coming from the outside. It is we, we alone, who can, by enfranchising and marrying out, little by little, those we possess, and buying no more, end a custom as bad to ourselves as to them. Every scheme in which we do not participate will end by doing the slaves more harm than they will ever suffer in a harem."

The extreme of injury done to the body politic by a mode of

life which entirely divorces the public interests of women and men is strikingly illustrated in the vicissitudes of Mohammedanism. In the Koran itself there originally existed conditions which, taken as a whole, were far more favorable to women than the common law of England. Originally, women of the Mohammedan faith were as highly educated and moved abroad as freely as men, mingling unveiled in their company, and actively participating in public affairs. Those were the centuries when the liberal and enlightened rule of Mohammedans made the name of Spain glorious, and when all Europe sought education in Mohammedan universities. It was during those centuries that the Turk passed from victory to victory, proceeding from western Asia into Europe, until his conquering army stood on the eve of a conquest of Austria.

But, as had so often happened before in warlike nations grown rich with enormous booty, women of the higher class surrendered themselves more and more to an indoor life of extravagant luxury and idleness, only too truthfully mirrored in the tales of "A Thousand and One Nights." The veil was doubtless at first worn as a sort of portable tent, into which one could withdraw to escape the bold stare of unwelcome admirers; partly as a result of a growing refinement, which led them to shun the gaze of a rude soldiery; partly to enhance their own attractiveness by affected concealment of their beauty. Thus in England also, during the warlike period of the Crusades, English women of rank habitually wore, even within doors, a veil which could be used for such purposes. And the somewhat like circumstances resulting from like causes conspired to make the English woman, likewise, at one period of her history, a creature whose dense ignorance and silliness equaled that found in the Turkish harem. The Asiatic woman, however, having once become an *objet de luxe*, plunged deeper into the gulf of helplessness, and has much more slowly begun to grow out of that condition. She is as one fallen into a pit, who can only escape by her own co-operation, but whose enervated arms are so weakened that every movement has become a burden. As woman is the life-stream of each race—the source which must be lifted high as the fountain is to rise—the enslavement of womanhood in Turkish harems has inevitably wrought its own revenge of terrible evil upon the nominal enslavers. Most miserable to-day is the lot of that people born of a race of slave mothers; most significantly is that debilitated empire known as "the Sick Man of Europe." Nothing but a patient upbuilding from the very foundation can restore that invalid whose disease is so deep-seated and long-abiding. This upbuilding has already begun. The elixir of modern ideas has not stopped with placing novels and teaching

showy accomplishments to girls in the harem. Already the invalid has begun to help himself by free schools and public libraries, which must inevitably, in time, revolutionize public thought. Even if the germ of the desire for freedom has, as Adalet confesses, entered woman's views in its least desirable form, it is something to have the love of freedom reawakened at the source whence youth draws its first impressions; and, after the desire for freedom for what it can give to the woman herself, must surely follow a desire for that which will enable her to give most worthily to others.

WHERE BANANAS GROW.

By JAMES ELLIS HUMPHREY.

IN spite of the fact that a bunch of bananas was a rare sight, and a single one a luxury, when we who are still young were children, they have become so common that we have ceased to ask the questions naturally prompted by unaccustomed sights; and this, not because those questions are no longer unanswered, but as the result of that familiarity which makes us forget our ignorance. We know that we owe this acceptable addition to our bill of fare to the tropics. We admire its texture and enjoy its flavor; but we rarely give it serious thought unless constrained to do so while yielding to the smooth invitation to tarry a while that its cast-off skin extends. We shudder at dreadful stories of venomous tarantulas and scorpions lurking in those compact clusters; and the horrors of a region that harbors such creatures outweigh all other thoughts. Concerning the facts of its climate, the growth of its products, the life of its people, we rarely inquire.

There is, perhaps, no other temperate country where the use of fruit is so widespread or so extensive as in the United States. Not only does our own unrivaled domain furnish varied soils and climates perfectly adapted to the temperate and subtropical fruits of the world, but our facilities for transporting and preserving them place the products of the most favored regions within reach of every one during prolonged seasons. The dweller in New York or Boston is thus able to supplement his home fruits by those of Delaware and New Jersey, of the Indian River, and of Los Angeles and San Bernardino in an uninterrupted and unfailing succession which has nearly banished the dried apple of our childhood.

But the influence of external conditions is as potent here as in other features of our life, and the nature of the food supply

largely determines the character of our food. We owe our good fortune to the abundance and cheapness of the fruit brought to our gates even more than to our growing appreciation of the hygienic value of good fruit. Our neighbors of northern Europe are relatively so far removed from fruit-growing regions that their winter supply of fresh fruit seems likely to remain limited and costly, however great their willingness to buy.

The stores of fruit which have been instrumental in this happy development of a nation of fruit-eaters in the last generation have come, as has been said, chiefly from our own territory. But the banana, which has played as great a part as any one sort, is strictly tropical, sensitive to very moderate cold, and growing safely in our own country only in extreme southern Florida. But here is little good banana land, and the prospective grower of this fruit must look beyond, to the South, for the scene of his operations.

The banana is probably a native of southern Asia and the Malay Archipelago, but has been known and esteemed from very early times in tropical America. It is now extensively cultivated in the West Indies and Central America both for home consumption and for export. One may form some idea of the growth of our appreciation of bananas from the statement of one familiar with the trade for the past twenty-five years, that an importation of twenty-five hundred bunches into Boston in a summer week, twenty years ago, could with the greatest difficulty be disposed of. Yet the usual receipts for a corresponding period at present are over fifty thousand bunches, and double that number have found a market in a single week. We may try to realize something of the quantity of bananas we eat from the careful trade estimate of importations into the United States in 1892, which is as follows:

Into New Orleans	4,483,351	bunches.
Into New York	3,715,625	"
Into Philadelphia	1,818,328	"
Into Boston	1,710,005	"
Into Baltimore	625,077	"
Into minor Southern ports	343,000	"

The total of 12,695,386 bunches represents an increase of 1,578,632 bunches over the previous year. It is true that when we talk of millions of bunches, which means hundreds of millions of bananas, the mind quite fails to grasp the hugeness of the fact. So we may add that this quantity represents about twenty bananas to each person in the whole United States, and a value of not less than five million dollars at the points of shipment before they are placed on board. Formerly our Northern ports received a large part of their supply from Central America and the Isthmus; but

more recently the shorter distance and better fruit have given the advantage to the nearer islands; and now, while New Orleans still draws from the older source, Cuba and Jamaica supply the North almost exclusively; and of these two, Jamaica is the more fertile, yields better fruit, is the more healthful in climate, the more beautiful for scenery, the more agreeable for residence or travel. A visit to the "gem of the Antilles, then," may show us something of the growth and treatment of this fruit which has come to vie with our own apples as a staple article in our dietary.

Like the palms and the grains, the banana plant is one of the "endogenous" plants of the older botanists. Its nearest relatives familiar in our climate are the *Cannas*, of late much grown, which give to our summer lawns an air so distinguished and so tropical. While broad-leaved, like the *Cannas*, the banana plant has the treelike aspect of the palms, with a stout, erect, and rounded bole capped by the splendid cluster of spreading leaves. Yet, unlike the palms, it is not truly a tree; for, while the palms, like all trees, have solid, woody trunks, albeit constructed on a plan radically different from that of the woody plants of our own fields, the apparent trunk of the "banana tree" is made up only of the soft, sheathing bases of the leaves. These arise from the true stem, a rounded, fleshy mass at the surface of the ground, from which also the roots descend. The huge leaf-bases, several feet in length, tightly inclose each other and form a compact body as thick as a man's thigh, narrowing upward into short leaf-stalks, which bear the large though graceful oblong blades. Within this cylinder of leaf-bases is the growing-point, or bud, from which new leaves continue to be pushed forth until the plant is full grown. Each leaf emerges in its turn from the center of the crown of leaves, a beautiful, erect roll, pushing straight upward into the air. Gradually unrolling as it finds room, the blade at last flattens out and bends to one side, and another leaf is added to the crown. Few leaves are more attractive than these young banana leaves in their first freshness of delicate green, of perfect form and grace, and of spotless purity. But with increasing age the color deepens, and the first wind and rain tear the exquisite blade in numberless places between its parallel veins; so that an old leaf becomes finally but two rows of ribbons and tatters, dull or dry, fringing a battered leaf-stalk.

After the last leaf has pushed forth and the foliage crown is complete, there appears from its middle the bud for which all the previous activity of the plant has been but the preparation. It emerges as a lanceolate mass borne on a rapidly lengthening stalk. The compact bud may be seen to be composed of close-set purple bracts of fleshy, leaflike texture, tightly overlapping. After a time the outer bract is raised from the underlying ones

and, separating more and more, at length falls away, leaving a scar to mark its place, and, just within the scar, a group of tubular, pale yellow flowers. Their petals soon wither and fall away, leaving the ovaries as a row of tiny bananas which will become one of the "hands" of the future bunch. Thus successive bracts fall away from the bud and successive rows of bananas appear. But after a time, though the bracts continue to fall and to uncover new flower clusters, these are found to be sterile, and young fruits are no longer formed. A bud may, then, contain only two or three fertile bracts, or it may have as many as fifteen or more

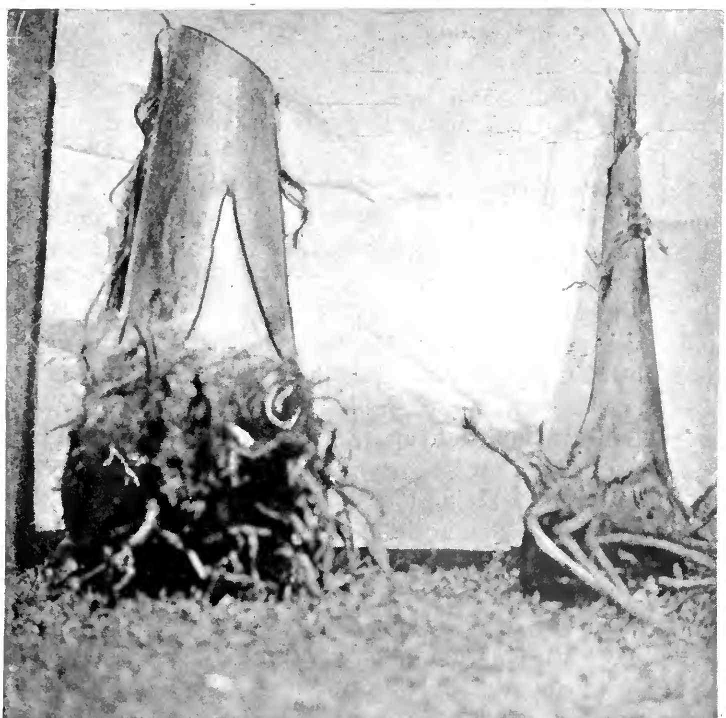

FIG. 1.—BUTT OF BANANA PLANT, WITH "EYE," AND "SET" READY FOR PLANTING.

—that is, the number of fruit clusters in the ripened bunch may vary between those extremes. The development of sterile flowers continues indefinitely. Each bract, as it falls, uncovers a fresh group to furnish pollen for the impregnation of the fertile flowers of a neighboring plant, as those of their own bunch, uncovered first, have already received the fructifying stimulus from a neighbor. Thus Nature provides for the cross-fertilization on which, as Mr. Darwin first showed us, she lays so much stress, sending the fecundating dust from plant to plant by those loveliest and swiftest of her messengers, the humming birds, and rewarding

their industrious service with frequent draughts of nectar of her own inimitable brew.

While the flowers are thus developing and giving place to fruits, the stalk of the bunch is lengthening and carrying the clusters farther apart, making room for the growth of the fruits, which pretty well keeps pace with that of the stalk. Very early the stalk begins to bend over and, as soon as it has become long enough, turns completely on itself. Thus the bud, and finally the bunch of fruit, hang downward between the leaves. On the other hand, the young bananas turn upward in their growth, and come at last to point directly up. As the tip of the stalk still lengthens, when the bananas are full grown it often hangs a yard below them, tipped by the purple plummet of yet unfallen bracts. It is by this sterile stalk that we see the bunches hung in our shops; that is, in a position just the reverse of that in which they grow.

In the Eastern tropics, the number of varieties and species of bananas and banana-like plants is large; but in America those which are cultivated to any extent are very few. Indeed, of true bananas we need notice only two. The common yellow variety, which is almost exclusively that which our markets receive, is the only one raised in Jamaica, and the chief one everywhere. But in Cuba and Central America the stout, red-skinned variety is still somewhat cultivated and occasionally shipped. It produces smaller bunches, but larger fruits, as a rule, than the yellow one. Another plant, so like the banana in habit as to be practically indistinguishable, but with larger yellow fruits which are eaten only when cooked, is the plantain. Its fruit is a staple article of food with the natives of Jamaica; and, when sliced and fried in sweet cocoanut oil as a creole cook can do it, is a dish to tickle the palate on which the flesh-pots of Egypt pall.

It is a matter of common observation that bananas contain no seeds. Cultivation through unnumbered generations has led to the atrophy of these organs through the substitution of a vegetative mode of propagation, much to the advantage of the eater of the fruit, at least. Only in one or two isolated regions of the Old World are the primitive seed-bearing bananas known. If we examine the rounded mass at the base of a well-grown plant, which is its true stem, there will be found one or more knob-like outgrowths which are plainly large buds. As the plant becomes older, these buds, or "eyes," as the banana grower calls them, develop upward, breaking through the soil and unfolding their first leaves. From the bases of their own stems, which are merely differentiated bits of the stem of the parent plant, roots are sent down; and thus the shoots become separated or capable of separation from the parent, and so, of independent life. At this stage

the plantlets, now perhaps two feet long, are called "sets," and it is these which, taken from a vigorous plantation, are used for establishing a new one.

Although they will do fairly well in the climate of Jamaica in a great variety of soils, the best land for bananas is the deep, rich, and moist alluvium of the river valleys. Here plants and fruit reach their perfection, and the largest returns reward the least labor. In short, the very lands which were the basis of Jamaica's wealth in the old days of sugar and rum and slavery, and which, during the years of her decadence, have lain waste

FIG. 2.—NATIVE HILLSIDE HOMES SURROUNDED BY BANANAS.

and "in ruinate," are destined again to give her a substantial prosperity in the new days of the banana and the cocoanut and freedom. And we may hope that this prosperity will be more real and more permanent than the former, because founded on principles of personal liberty and righteous dealing, and without the accompaniment of the semi-barbarous luxury and the wholly barbarous license that cursed the former time.

It is but a few years since the crumbling evidences of the material prosperity of the rule of sugar and rum were to be seen on every hand. Magnificent estates, teeming with a tropical luxuri-

ance of riotous vegetation, only awaiting the directing hand to turn their fertility to use, were everywhere. Old sugar works and stillhouses, monumentally built of stone, still contained the massive remains of machinery which even the corrosion of the tropics had not yet wholly destroyed. And on each estate the splendid "great house," still splendid in its desolation, enshrouded in creepers and climbers, in clinging mosses and "wild pines" and orchids, stood an eloquently mute witness to the external grandeur of the life of the sugar planter of an earlier part of the century. And all these things are still far too common. But already the change is evident. These old estates are being rapidly taken up and cleared. The great houses are being renovated or replaced by new if less pretentious homes. Life and activity are replacing death and decay. One hears of thrifty men who have bought fine estates, renovated and equipped them, and established fruit plantations hundreds of acres in extent, at an expense of thousands of pounds, and from the profits of the first five years have stood free of debt and independent. These are not isolated or exaggerated cases; but they will, of course, become less frequent as the fruit supply increases. The pioneer in growing and shipping fruit has been a Cape Cod sea captain, who, trading among the islands, had the foresight to seize the opportunity when it was his for the seizing, and faith that Americans would buy all the fruit he could offer them. In twenty years his real estate and shipping interests have grown too extensive for a single man, and are now in the hands of the Boston Fruit Company, of whose Jamaica interests he is still in charge. This company now owns or controls over thirty of the finest fruit estates in the island, from Morant Bay around the eastern end as far as Buff Bay. Jamaicans cordially recognize their indebtedness to Captain L. D. Baker for the present hopeful outlook for their island.

One of the largest and perhaps the most successful of the fruit company's estates is that called "Golden Vale," eight miles south of Port Antonio, its headquarters in the island. Here some two hundred acres of genuine "banana land" are now under cultivation, and the area is being steadily increased. A visit to this plantation will give the best idea of the details of banana culture. The road takes us directly away from the coast through the hills that come down to the very shore almost everywhere in eastern Jamaica. The fine government roads make driving a pleasure, and the magnificent hill views and wonderful vegetation are an unfailing delight. So it is all too soon that we descend the hills into the valley of the Rio Grande, pass through the plantation and settlement of "Friendship," on the hither side, ford the river with wheels hub deep in water, and enter Golden Vale. Thanks

to a telephonic message that has preceded us, the superintendent awaits us to show us everything of interest and, with unfailing courtesy, to answer the endless questions of a Yankee.

After the ground is cleared, holes about a foot and a half deep are dug fifteen feet apart each way. They are then filled with surface soil to a depth of six inches, leaving them a foot deep. In these holes the sets are then placed obliquely, so that their upper ends just project beyond the edges of the holes, and are covered closely. Many planters place the sets upright and cover only their bases; but, though they then make plants rather more quickly, the best growers believe the resulting plants are not so strong, and produce less and poorer fruit. A set covered as above may then "shoot," in technical parlance, either from an eye at the base of the set or by the continued growth of its principal bud within the sheathing leaves. This results in a new growth bursting through the old leaf-bases—"breaking the husk," the growers say—and is considered to give the best plants. Good sets will show vigorous growth in three or four, sometimes even in two, weeks after planting, and then grow rapidly, pushing out leaf after leaf, and finally the flower stalk. At length, eleven or twelve months after planting in good soil, each plant stands from twelve to fifteen feet high, and bears a bunch of fruit full grown. Since a plant bears only a single bunch of fruit, it is removed when the bunch is cut to make room for another. And by the time it is ready for cutting others are ready to take its place in the young plants which have come up all about it from the lateral sprouts of its stem. The best of these are selected to remain and the rest removed. In this selection of plants and the resulting thinning lie the secret of success with bananas. The first to grow from sets in a new plantation are called "plants," while succeeding growths from their shoots are "rattoons," first, second, third, and so on, in succeeding generations. This word *rattoon* is a corruption of the Spanish *retoño,* a new shoot, and originated in connection with the culture of sugar cane, which is propagated in the same way. An amusing example of the extent of its use may be seen in the Jamaican reference to a meal made off the remnants of a previous feast as "eating the rattoons."

By careful selection and thinning of the rattoons a good plantation comes in a couple of years to its full development. Then one finds, as nearly as may be, in each "hill," as we may call the group of plants standing where each original set was placed, four plants strong, vigorous, and in stages of development which present a regular succession from oldest to youngest. Placing the hills fifteen feet apart each way gives nearly two hundred to the acre, and a well-managed cultivation should yield two marketable bunches per hill a year. The plants and first

rattoons give the best fruit, and there is a steady degeneration with succeeding rattoons. The limit of profitable yield for a plantation varies especially with the soil. But the maximum for deep and moist banana lands may be said to be about ten years. Then the ground must be cleared and a new culture begun with fresh sets. Very little is done in rotation of crops, and the soil has as yet received little fertilization except such as results from the decay of the old plants.

It is not alone on the great estates, nor even chiefly on them, that our enormous supplies of fruit are being produced. Scattered

FIG. 3.—IN THE "GOLDEN VALE" PLANTATION.

all over the hills are little clearings of a few acres, or even less than one acre, thickly set with banana plants. It is from these little patches that perhaps a majority of our fruit comes. For even the Boston Fruit Company, with all its estates, is compelled to buy largely to supply its trade, and most of the other shippers are wholly buyers. Thus the smaller and less available tracts are turned to account, which is a matter of the first importance in a country so irregular and so mountainous as Jamaica.

Whether for shipment or for home consumption the fruit is cut as soon as it is "full"—that is, when it has reached its adult

form and size, but is still quite green. The plant is cut off by a single blow of a machete wielded by a powerful arm. As it falls the bunch is caught, lopped off, and laid aside, while the harvester goes on to the next bunch. It is a popular supposition that bananas "ripened on the tree" are incomparably superior to those cut green. But as a matter of fact one never eats them thus ripened in Jamaica. They are said to be not so good; at all events, one finds no better fruit in texture or flavor than the best of our own markets. But every lover of this fruit knows that its quality varies extraordinarily as it is offered to us. This is due partly to the different sources from which it comes. The best that is brought to us comes from Jamaica. It is also due still more to the condition of the fruit when cut. Bananas which are perfectly full will ripen mellow and delicious; but those cut when immature, as too many are, will turn yellow, yet never truly ripen, retaining always their hard texture and unripe taste. In Jamaica, as elsewhere, the competition of buyers leads the unscrupulous ones to accept fruit of any sort, even when totally unfit; and this sort of competition makes all the more unavailing the efforts of honest buyers to raise the standard and to teach the people to withhold their fruit until it is properly developed. Americans can give moral support to these efforts by accepting only such fruit as is mature at any price. A little pains will soon enable one to distinguish good from poor fruit, though it is difficult to give a general statement of the distinctive differences. But, as a rule, it will be found that bananas which are largest, deepest yellow, and least angular are the most mature and best.

The view over Golden Vale from the superintendent's house, which stands at a little distance on a slight elevation, recalls a grain field with its level surface of waving foliage. The drive along the roads within the plantation is beautiful. One may go on and on between the stretches of luxuriant plants, to the soft rustle of the leaves overhead, while below the forests of trunks reach away on either hand beyond the power of the eye to penetrate. But the experience never to be forgotten is a ride over the estate with the superintendent. On tough little Jamaica horses, docile and sure-footed, we leave at once the wagon road, plunge into the wilderness of plants, and soon lose sight of every landmark. Pushing on, sometimes along foot paths just distinguishable, oftenest where there are none; jumping ditches and prostrate trunks, surrounded only by banana plants in all stages of growth, yet so alike, so monotonous, that one might as easily find his way in midocean. Above us is an overarching roof of foliage supported by massive clustered columns. Beneath our feet is a dense carpet of some of the prized adornments of Northern greenhouses —the *Tradescantia* or "wandering Jew," beautifully contrasting

the deep maroon of the lower faces of its leaves with the green and silvery stripes of their upper sides; the delicate pink-flowered *Oxalis*, and the dainty "sensitive plant," whose modest shrinking from the slightest touch has been uncharitably attributed to a bad conscience, both by the botanist who named it *Mimosa pudica* and by the darky boys who call it "shame." Emerging at last into the full blaze of the tropic sun, which seems all the more garish by contrast, we cross the open for a time and soon begin the ascent, by a slight bridle path, of one of the steep hills that inclose the valley. Slowly but surely the horse creeps upward, now stopping with all four feet together to poise for a leap over a gully, then pressing on over a track that nothing else but a mountain goat could climb, close past and under trees that almost brush one from the saddle. At length we come out upon open ground near the summit, to be a hundredfold repaid by one of the fairest sights the fancy can paint. At our feet lies the sea of bananas; beyond and on either side stretches the amphitheater of hills, plumed with cocoanut palms and fringed with feathery bamboos, and covered with verdure. Back to the house by a good path, we taste true Jamaican hospitality in a cup of tea and that most melting and luscious of Jamaica's fruits, a Ripley pine—no one says pineapple here.

After cutting, it is important to ship the bananas as promptly as possible and to handle them carefully, for the less they have ripened or been bruised before reaching their market the better prices they bring. So each bunch is carefully wrapped with "trash"—dried banana leaves—and taken at once to the nearest shipping port. From the great properties like Golden Vale they are transported in two-wheeled or four-wheeled mule carts, the former drawn by two mules, the latter by three abreast, carrying, respectively, about twenty and forty bunches. These carts are lined with trash to prevent bruising. The mule team consists of a large mule in the shafts and a small one harnessed to an outrigger on one side or on each side, as the case may be. From the smaller clearings and dooryard patches of the peasants come single bunches on the heads of their owners, or lots of two or four bunches packed in trash and slung pannier-fashion across the backs of donkeys.

As the bunches are received at the wharf they are unpacked, inspected, and checked off by a tallyman, and placed in trash-lined bins according to their size and quality. A glance shows an experienced eye how many groups or "hands" of bananas a bunch contains. A bunch of nine or more hands is a whole bunch, and brings the full-bunch price either at the port of shipment or in the Northern market. I am told that bunches of sixteen hands are occasionally met with, but have never seen one of more than

thirteen. A bunch of eight hands is a three-quarter bunch, one of seven hands a half bunch, and a six-hand bunch sells for a quarter or a third of the full-bunch price. Bunches below this size are not ordinarily marketable. Since a hand may contain from a dozen to twenty fruits or "fingers," the number in a marketable bunch may vary from six to twenty dozen. The poorer bunches are sometimes reserved for the few schooners still in the

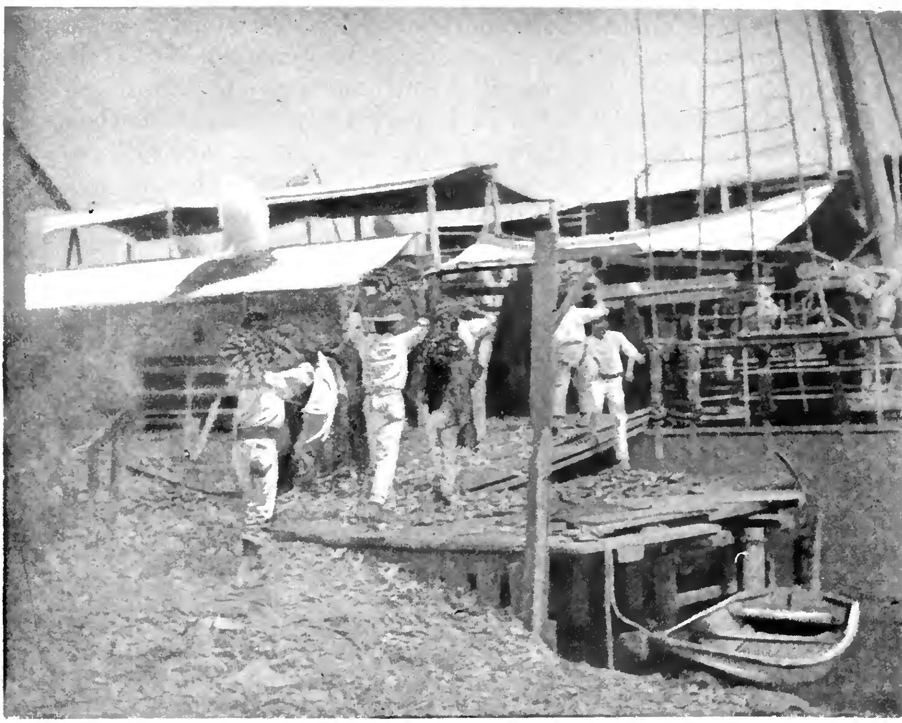

FIG. 4.—LOADING AT THE WHARF, PORT ANTONIO.

trade, chiefly with our Southern ports, while all the best go by steamers.

Originally the entire trade was carried on in sailing vessels, but their slowness and uncertainty have compelled them to give way to the present fleet of stanch and fast steamers, whose regular time of about five days to New York and six to Boston from Jamaica, or half a day less from Baracoa, Cuba's largest fruit port, gives them every advantage in the transportation of perishable freight, in spite of greater running expenses. Most of these steamers, while built especially for the fruit trade, are of the class called tramps, taking short charters wherever they can obtain them, and with no allegiance but to their owners. It is with a twinge of regret that an American sees ship after ship, as she

enters port, break out at her taffrail the ensign of Britain or of Norway.

There are but five ports in the West Indies and Central America which boast wharves where ships may load or passengers may land. Two of these are chief centers of the fruit trade in Jamaica—Port Antonio and Port Morant—which owe their facilities to the enterprise of the Boston Fruit Company. Here the fruit is transferred to the ships, bunch by bunch, upon the shoulders of men. But at all the other ports, which lie scattered along the northern and eastern coasts at intervals of ten to thirty miles, from Morant Bay to Lucca, ships must anchor an eighth to half a mile off shore, and receive their cargoes from large surfboats, manned each by three stout negroes, two rowing in the bow and the other standing in the stern, alternately sculling and steering. These boats bring out at each load from a hundred and fifty to two hundred bunches, which are passed on board ship by way of a staging let half way down her side. Each bunch, as it comes on board, whether from wharf or boat, is passed down a line of men reaching from the deck to that part of the hold which is being filled. The first man, as he receives the bunch, calls out its number in series, and, following him, the tallyman on deck keeps the score in his book. Often half a dozen men will join in the refrain:

"One—let 'er go.
Two—put 'em down.
Three—carefully.
Four—banana.
Tally—oh——!"

This is shouted or chanted with a slow rhythmic swing, and is most frequently heard at night. At such a time—for when once the loading of a ship is begun it continues without interruption until she is ready to sail—the effect is particularly weird. The splash of the oars of boats emerging from the darkness, the shouts of the men, the scantily clothed dark forms dimly lighted by flaring lanterns, and, dominating all, this almost unintelligible chant, suggest some orgy of voodoo. In the hold the bunches are placed upright, resting on the thick ends of their stems, and as close together as possible.

So a steamer is loaded, in from twenty-four to forty-eight hours, with twelve to fifteen, or rarely twenty, thousand bunches. In the busy season, from April through July, the Boston Fruit Company alone loads five ships per week on an average, including two for Boston and two for Baltimore. Their supplies are drawn chiefly from the region between Morant Bay and St. Ann's Bay, and up the east coast as far as Annotto Bay they are the chief shippers. Their leading competitors are the Jamaica Fruit Com-

pany, at Port Antonio, which supplies its Jamaica fruit to the Philadelphia market, and J. E. Kerr & Co., the leading buyers between Annotto Bay and Lucca, who run steamers to New York. Besides these there are numerous smaller buyers. Unfortunately, it can not be said that all buyers deal fairly with the people, though they keep their trade by taking all fruit that offers, regardless of its quality or fitness. Many of them are dealers in general merchandise, and, by paying their ignorant clients in goods, not only make a double profit, but keep running accounts with them which are never closed and always show a balance on

Fig. 5.—Loading from a Boat, Buff Bay.

the dealer's side. While this may not be carried as far as the infamous truck system, which holds the people of the Bahamas in practical slavery, the tendency is the same, and should be sharply checked before its logical conclusion is realized.

And now something as to the people who are engaged in the work of culture and shipment already described. With few exceptions they are native Jamaicans. Some of the most responsible positions in the Boston Fruit Company's offices at Port Antonio and Port Morant are filled by Americans, who with their families form a delightful colony at the former place. To them

visiting Americans are indebted for many kindnesses. The clerks and tallymen at the ports, the superintendents and overseers, or "head bushers," on the cultivations are chiefly white, creole, or mulatto Jamaicans. A parenthesis here about this word "creole." Webster and others define a creole as a child of white parents born in the tropics; but this certainly is not the popular use of the term in Jamaica. There it is synonymous with the perhaps commoner expression "brown man," and is applied to a person with a small proportion of negro blood, which, while showing its presence slightly in complexion or hair, or both, still distinguishes its possessor but slightly from a white person. These people are far more numerous than the whites in Jamaica, and enjoy complete social equality with them. This is not only fortunate for all concerned, but is the inevitable result of the free intermarriage of persons of all shades of complexion and all degrees of blood mixture, as well as of the looser relations which were even recently very common, but which, happily, seem at present to be less condoned among people with claims to respectability. One always finds Jamaicans of the better class kindly, hospitable, polite, and unaffected, without the veneer of more elaborate civilization.

But the manual labor in any industry is largely performed by the negro peasantry, who constitute a very large and steadily increasing majority of the population of the island. In the culture and shipment of the banana both men and women were formerly employed, but at present men are almost exclusively engaged, receiving from one to two shillings per day, according to the work. There is much of interest about the Jamaica negro—some good points and many bad ones; but this is not the occasion for their detailed discussion. His life is a curious combination of almost primitive savagery, with some of the least attractive features of our so-called civilization. Living chiefly in wattled bamboo huts thatched with palm leaves, and upon the lavish products of the soil, dressing in the simplest manner, his wants are easily supplied. Very religious in theory and equally immoral in practice, a child in mind and an animal in spirit, he presents a practical problem worthy of any philanthropist's best efforts.

The short time in which, even at his small wages, he can provide for the needs of a week, his entire lack of ambition for more than a bare subsistence, and the seductions of that liquid fire called new rum, make the average negro an uncertain quantity in the labor problem. This has led to the importation into the British West Indies of a class of steadier and more reliable laborers, the low-caste Hindus, or coolies, from India. These slender-limbed and bronze-skinned Caucasians are, as a class, temperate, industrious, and frugal; quiet and peaceable when fairly treated. They make excellent laborers, and their picturesque and comfortable

costumes are far better suited to the climate than the imported European one which the negro apes. Living by themselves in villages of bamboo huts, the coolies have little intercourse with the negroes, whom they regard as their inferiors; and rightly so, from a mental or moral standpoint. The negro, on the other hand, looks down on them, but has learned from experience that their reserved and quiet manners are no more the outward sign of timidity than his own bluster and braggadocio can replace real courage in an emergency.

The typical agricultural tool in Jamaica is the machete. These heavy, swordlike blades are made in Europe and have clumsy handles with grips of rough wood. For a good one the buyer pays a shilling, and then takes it to a smith. Here the wooden grips are removed and a large strip is cut out from the handle to make it narrower and more comfortable; the blade is ground to a keen edge, and its sharp tip is cut off as a safeguard against too serious accident should the tool be dropped upon some always naked foot. The owner now fits to the handle convenient grips, preferably of calabash wood, winds them evenly and tightly with stout cord, and his constant companion is ready at a total expense

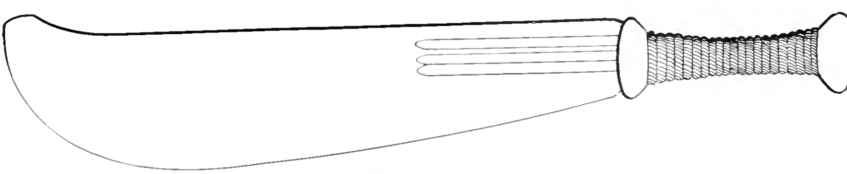

Fig. 6.—Machete ready for Use.

of about two shillings. Whether for grubbing up weeds and clearing ground, for gathering grass for his donkey, for harvesting bananas, for cutting yam-poles, or for husking cocoanuts, this implement is indispensable. It is formidable in appearance, and would be so in fact were its owner disposed to use it with sanguinary intent. But, happily, he has rarely the courage that makes a dangerous man, and the blood of the cocoanut is the machete's most exciting draught.

To return to our bananas. When the responsibility of the Jamaica people ends with the sailing of the ship, its captain's responsibility begins. And this is no slight one. In warm weather the holds must be kept wide open but constantly protected from the sun by awnings, and the great ventilating funnels must always be turned to catch the full force of the wind and change the air below as often as possible. In cold weather it may be necessary to cover the hatches and close the ventilators to prevent the freezing of the delicate cargo as our shore is neared. And if the ship arrives during a cold snap she may have to lie several days

before the weather will permit unloading. Either the closeness of the air beneath tightly battened hatches or the heat of midsummer weather causes the rapid ripening of the fruit, and it may be the case at either season that when the ship is unloaded there is found a mass of ripe and decayed fruit which will not pay the cost of its transportation. Thus the shipper's lot is likely to be by no means a happy one, and the success of a trip may depend largely on the skill and judgment of the shipmaster.

Fruit which arrives in good condition is transferred by wagons to cool and dark storehouses to ripen, or by rail to interior markets with the utmost dispatch. One may often see a fruiter just arrived at her pier in one of our large seaports, by whose side lies a huge scow bearing freight cars, into which the green bunches are being rapidly passed and stowed for transportation hundreds of miles inland.

And so, throughout the year, the work goes on, affording profitable occupation to people who need it and healthful variety to tables that welcome it. Surely the story of one of the choicest products of Nature's laboratory can not be without interest where that of every result of human ingenuity finds so large an audience.

TYNDALL AND HIS AMERICAN VISIT.*

By Miss E. A. YOUMANS.

IN the death of Prof. Tyndall science has lost one of its greatest modern leaders, and the century one of its most striking personalities. In early life he became prominent as an original investigator, and later he was even more distinguished as a popular scientific teacher. Probably no man of his time did more toward freeing science from the shackles of ecclesiasticism, and vindicating its claims to public regard. With less than the usual advantages of birth or position, he rose by sheer force of character and natural ability to the headship of one of the foremost scientific institutions of learning and research in the world, the Royal Institution of Great Britain. Here, as Professor of Physics, which appointment he received in 1853, he continued those original researches which had already made his name familiar in scientific circles, and subsequently, on the death of Faraday, he succeeded to the directorship of the institution.

His researches in physics embraced magnetism, electricity, light, heat, and sound, the latter including a long series of experiments on the atmosphere as a vehicle of sound, with a view to the

* A biographical sketch of Prof. Tyndall, with a portrait on steel, appeared in The Popular Science Monthly for November, 1872.

establishment of fog signals on the coast of England. Indeed, his studies branched out toward the practical in a variety of directions; chief among them being his investigations concerning the nature of the dust particles in the air, and their relation to the germ theory of disease.

It is said that he had from youth a faculty of examining his premises with extreme minuteness, so that he was hardly ever known to proceed on a false assumption; and no theory ever propounded by him as the result of mature deliberation has been upset or seriously controverted. Another of his characteristics was that a research once entered upon, the work was carried on with the unflagging industry and persistence of an enthusiast. He has himself furnished the explanation of this in the following passage taken from his later writings:

> My going to Germany had been opposed by some of my friends as quixotic, and my life there might perhaps not be unfairly thus described. I did not work for money; I was not even spurred by the "last infirmity of noble minds." I had been reading Fichte and Emerson and Carlyle, and had been infected by the spirit of these great men. The Alpha and Omega of their teaching was loyalty to duty. Higher knowledge and greater strength were within reach of the man who unflinchingly enacted his best insight. It was a noble doctrine. It held me to my work, and in the long, cold mornings of the German winter, defended by a Schlafrock lined with catskin, I usually felt a freshness and strength—a joy in mere living and working derived from perfect health—which was something different from the malady of self-righteousness.

Again he says of this German experience:

> I risked this expenditure of time and money not because I had any definite prospect of material profit in view, but because I thought the cultivation of the intellect important—because, moreover, I loved my work and entertained the sure and certain hope that, armed with knowledge, one can successfully fight one's way through the world. And I must not omit one additional motive, which was a sense of duty. Every young man of high aims must, I think, have a spice of this principle within him. There are sure to be hours in his life when his outlook will be dark, his work difficult, and his intellectual future uncertain. Over such periods, when the stimulus of success is absent, he must be carried by his sense ot duty.

But it was his power as a scientific expositor that gave Prof. Tyndall his worldwide reputation, and it is on this that his fame chiefly rests. His ability to present even abstruse subjects to a popular audience was unexcelled. The vividness of his imagination, which enabled him to form clear mental pictures of the phenomena he sought to explain, and his aptness in illustration led him to translate abstract ideas into their concrete equivalents.

On this point, the Athenæum remarks:

> His lectures were not merely marked by logical reasoning expressed in forcible language, but they were models of method: nothing was left to chance;

everything, down to the minutest detail, was prepared with nicety; and the experiments were consequently performed with a precision unequaled by the manipulation of an accomplished conjurer.

The qualities which characterized his lectures were reflected, as far as possible, in his writings. There was the same clearness of thought, the same vigor of expression. Most of his writings were, indeed, reproductions or developments of his lectures; witness his popular works on Sound, Light, and The Forms of Water. His best-known book, Heat considered as a Mode of Motion—in which he presented, thirty years ago, an admirable exposition of the phenomena of heat in accordance with the dynamical theory—may be accepted as typical of his felicity of expression and readiness of illustration.

It was these rare gifts as an interpreter of science which first drew the attention of American readers to Prof. Tyndall, and which finally led to his visit to this country in 1872. Many now living will recall that event and the impulse given to American science by the brilliant course of lectures which he delivered in our chief Atlantic cities.

Having been asked to prepare a brief account of this visit, and being assured that it will be of interest just now to the readers of the Monthly, I have decided to comply with the request. I am enabled to do this by the aid of documents and letters left by my lamented brother, E. L. Youmans, who for many years enjoyed the friendship of Prof. Tyndall, and was in frequent correspondence with him.

Tyndall's first book, The Glaciers of the Alps, was brought out here by Ticknor and Fields in 1861. All who read it were fascinated by the clearness and beauty of its style and the ease with which its facts and principles could be understood.

The year following, my brother made his first visit to England, and while in London it was his good fortune to be introduced to Tyndall. In a letter of September 25th he writes:

I went with Spencer at his request to see Tyndall respecting the publication of his forthcoming book. He was at the Royal Institution, where his researches are carried on in a dingy hole down cellar, which Tyndall denominated "the den." He is a single man of forty, with a scanty strip of forehead, and big, straight, prominent nose—the most restless, nervous creature I ever set eyes on. We stayed but a few minutes, and nothing was said of anything but the book, and the publication of books.

The work here referred to was Heat as a Mode of Motion, at that time in the hands of the printers in London.

Another letter written from Cambridge during the same visit, when he was attending the meeting of the British Association, describes Tyndall's manner as a lecturer:

Last night there was an address by Tyndall before the association in the lecture room; subject, water in its several conditions. It was altogether the most brilliant affair of the kind I have ever seen. The new philosophy of forces

permeates everything. All science seems worked with reference to it. Tyndall not only assumed it, but it was the foundation of his philosophy. While I was with him the other day Spencer started the point of using the term persistence of force rather than conservation. They had quite a spurt over it. But to-day Huxley used the term persistence of force. The experiments last night were, first, testing oxygen and hydrogen separately; second, exploding them together; third, bursting iron bottles by freezing; fourth, exhibiting the formation of crystals by the electric light in a vacuum; fifth, formation of an immense spectrum on a screen, absorption of its different parts by colored glasses; and sixth, regelation of iron. He had splendid diagrams of the glaciers, but hardly referred to them. He was not still a moment, but bending and twisting in all possible shapes as if he had the St. Vitus dance—twisting his legs together, bending down to the desk, and working and jerking himself in all possible directions. Everybody was kept awake, entertained, and instructed. It was a work of enthusiasm.

One of the consequences of that first interview with Tyndall appears in the following extract from a letter of my brother's written to Mr. Spencer in March, 1863. He says: "I received the advance sheets of Prof. Tyndall's book on Heat, and beg of you to express to him my sincere thanks for the kindness. The Appletons will issue it at the earliest moment, the cuts being already nearly all re-engraved. It is a very fascinating and altogether remarkable book, and it will be a pure pleasure for me to work for its circulation. It can not fail to have a good sale."

A letter of Prof. Tyndall's to my brother relating to the publication of his work on Heat, and bearing date April 29, 1863, is the earliest one in my possession. It is as follows:

My Dear Sir: As soon as I received the letter with which you kindly favored me some months ago, I communicated at once with Mr. Longman and requested him to forward you the separate sheets of my work on Heat according as they appeared. I intended to accompany the sheets with a letter which should express my desire to leave the management with the Messrs. Appleton entirely in your hands, but I have been so knocked about—sometimes so ill, sometimes so hard worked, and sometimes engaged so far away from London—that I have delayed thus far to write you. My friend Spencer called to see me a few days ago, and from him I had the great gratification of learning that the book has interested you. Indeed, he read portions of letters from Mrs. Youmans and yourself which gave me very great pleasure. Since the appearance of the work I have had communications from many of my eminent Continental friends regarding it, and they, I am happy to say, concur in your opinion. A French translation of it has already been commenced. I can assure you that I have spared no labor to render a difficult subject intelligible, and it gives me great pleasure to find that I have, at least in some measure, succeeded.

I am now giving a short course of lectures on Sound at the Royal Institution. If I have time I may throw them into a readable form. I have for some time entertained the idea of publishing my lectures gradually and of afterward collecting them and fusing them into a book on general physics. But the time necessary to the proper accomplishment of the task deters me almost from undertaking it. However, it may perhaps be executed by slow degrees.

Mr. Huxley informs me that you are thinking of bringing out his work also. I am glad to hear this, for it is an extremely able production. Indeed, there are parts of it which in point of writing power have scarcely ever been excelled. . . .

Good-by, my dear sir; accept my best thanks for the trouble you have taken in my behalf, and believe me Most sincerely yours,

JOHN TYNDALL.

The book appeared in the summer of 1863, two years after that on the Glaciers, and, although dealing with a difficult subject, was received with equal favor and appreciation. These two works gave their author a high reputation in America as a popular expositor of science, and created an eager demand for his later writings, nearly all of which have been republished by the same house, and have been widely read. Meanwhile Tyndall's success as an experimenter and his gifts as a popular lecturer had come to the knowledge of many Americans, and the result was a great desire on the part of our more intelligent classes to see and hear the man. This found expression in frequent solicitations to lecture in the United States, among others Mr. John Amory Lowell sending him an urgent invitation to come over and deliver the Lowell lectures in Boston. But it was not until some years later, on the receipt of a request signed by twenty-five names "distinguished in science, in literature, and in administrative position," that, yielding to his democratic sympathies and his ardor in the diffusion of science, Prof. Tyndall finally consented to come.

The first letter in which I find any mention of his coming to America is dated December 24, 1869. I give it entire:

MY DEAR YOUMANS: It is a long time since I have heard from you, and the reason, no doubt, is that you wrote to me last. Well, I must not allow you to fall utterly away from me, so by this day's post I send you the copy of an article which is to appear in the next number of the Fortnightly Review.

Your last letter made me smile. I know you imagine me to be a screw in money matters, and therefore you thought it would please me to know that I should be well paid for that short scrap from Macmillan. Well, if you feel an interest in the matter you may ask my friends whether I am a screw or not. Sometimes I certainly wish to put the screw upon publishers; for they sometimes need it much. Let me say now that you may do just what you please with any article of mine, and feel not a thought on the money side of it, as far as I am concerned.

I am trying very hard on a boy's book on optics. Ostensibly for boys, but equally for teachers; for boys thus far do not know how to learn and teachers do not know how to teach. I am so treating the subject that boys and teachers may make the experiments for themselves. My aim is to teach them both to experiment and to reason upon experiment. I suppose a boy to be alongside, and that we are working together. I try to overcome the apathy and the repugnance arising from awkwardness in the first stages of experiment. I speak, therefore, not only to the boy's *brain*, but to his *blood*—stirring him to action.

I had a fall with ugly consequences in the Alps this year. One morning, after allowing a mountain cascade to tumble over me, I was returning across

some blocks of granite naked to my clothes when I staggered and fell all my weight against the sharp crystals. Three of them stamped themselves into the fiber of my shin, and the shin was generally much bruised. But four days of perfect quiet destroyed all pain, and there was no inflammation. So I came down stairs, moved about, excited inflammation, had erysipelas twice over, and was six weeks in bed. It required three months to set me right. I am now well, and just on the point of beginning the Christmas lectures.

I wish much you would tell me what kind of lectures (scientific) you are accustomed to in New York. Yours ever,

JOHN TYNDALL.

The subject is again alluded to in the following letter:

April 13, 1870.

MY DEAR YOUMANS: I thank you more fully for the friendly interest you have taken in my affairs than for the money which has resulted to me through the exercise of your kindness.

I have had many letters of the most gratifying description from the United States, and this is why I mentioned lectures in my last note to you. I am not, however, certain whether it would not be better to pay you a visit without any thought of lecturing. I love freedom, and a scamper through the States, without the incubus of lectures, would be as instructive to me as it would be pleasant.

I saw Huxley last night. To him you have been acting as you have to me. The philosophers of England have much to thank you for. I was sorry to hear from Huxley that his little book is not so successful in America as it might be. This surprises me, for it is an excellent piece of work. I wish I had time to do something similar in physics.

When I last saw Spencer he was flourishing. He told me he had written to you regarding an amanuensis. He endeavors to persuade me to lighten my labors in this way. But with me an amanuensis would not be so successful as with him. I have to rasp and rasp at my work myself before it pleases me.

With regard to the future I have to say that I am pinned this year by the meeting of the British Association at Liverpool; next year I am pinned by my lectures and researches. If I go to the States without lecturing I could probably fly off in 1872. But should I lecture, the needful preparations would throw the visit back to 1874. This is a long time to look forward to.

But whether I go or tarry, or whether I go as a lecturer or as a friendly visitor, it will make no difference in the feelings with which I reciprocate the kindness shown to me by your countrymen and yourself.

With best regards to Mrs. Youmans,

Believe me, yours ever faithfully, JOHN TYNDALL.

Tyndall's next letter referring to the subject is interesting as showing the force of custom upon a man of such independence of character:

March 26, 1871.

MY DEAR YOUMANS: . . . The desire for lecturing in America seems to be very strong. My relative, Hector Tyndale, who is now in this country, was the bearer of a very flattering proposal to me. Suppose I ask *you* what would be expected of me were I to close with the terms suggested in your last letter? I

want to know the amount of slavery that will, under the contract, be inflicted on me.

I take it for granted that I should occupy no other position than that habitually accepted by such men as Emerson, Sumner, Wendell Phillips, Wendell Holmes. I should not, of course, dream of becoming a traveling lecturer in England, and I should as little dream of doing so in America if the constitution of society were not such as to render the work of lecturing not unworthy of your own best men.

The best men in England, be it remembered, would engage in nothing of the kind.

Between the time of his first visit to Europe, in 1862, and the time, ten years later, of Prof. Tyndall's coming to this country, my brother had made several visits abroad, and his acquaintance with Tyndall had ripened into friendship. In 1871, when he was in England establishing the International Scientific Series (of which the first volume was prepared by Tyndall), he received from him much friendly counsel and important aid, and, in fact, in a letter of June 23, 1871, from my brother, I find it stated that—

Tyndall is arranging to come over next year. Two illustrated lectures on the glaciers, two or three on heat, others on light and electricity. "I want you to take entire charge of me so far as the public is concerned; my assistant will take charge of experiments. I will not enslave myself. I will take it just as easy as I have a mind to. I don't want your money, nor will I bring away one dollar of it. I will help your scientific institutions with it; but it shall not be said that I went to America to line my pockets. I have no reflections to cast upon those Englishmen who have chosen to do this. It may have been right for them, but it won't do for me."

The next letter bearing upon the subject shows that plans for his lectures here were on foot, and that he had asked Prof. Henry to arrange the times and places for him. This is quite in keeping with English reverence for institutions, and Prof. Henry stood for the Smithsonian Institution.

May 28, 1872.

My Dear Youmans: You will have your kindness toward me tested by Prof. Henry in regard to the coming lectures. I wrote to him saying that I knew you would help me, and he has written to me to say he would call upon you.

He proposes five cities (and perhaps others) in which to lecture—I have expressed my willingness to give a course of six lectures in each at the rate of three a week. Two things render it desirable that the number should not exceed three a week. Firstly, I must keep up my physical vigor, and the night subsequent to a lecture is only too likely to be a sleepless one. Secondly, it is above all things desirable to make sure of the experimental arrangements the day before the lecture. . . . Yours ever, John Tyndall.

The revelation given in the next letter of Prof. Tyndall's mental state concerning the commercial resources of Boston is too characteristically English to be omitted:

August 31, 1872.

My Dear Youmans: I am in the midst of my preparations here, and shall have them ready so as to enable me to start in the Russia on the 28th of September.

I shall need your friendly aid in getting my apparatus through the custom house. . . .

With regard to the lecture rooms, in all of them I must be able to lower the lights promptly. Most of my experiments will be projected on a screen.

I purpose mixing experiment and philosophy in due proportions.

I deal with the illustrative phenomena of light: the laws of reflection and refraction, analysis and synthesis, the bearing and significance of theories. Spectrum analysis and its revelations regarding the constitution of the sun. The higher phenomena of optics, interference and polarization, reaction of crystals upon light. The building of crystals. The extension of radiation beyond the range of the eye. The identity of light and radiant heat. This is a rough sketch of the subjects which will probably occupy me. I shall not know for a certainty until my preparations are complete.

Do your audiences look down upon the lecturer?

I suppose I can borrow an air pump in New York if I need it.

I suppose if they do not possess ice in Boston I can have a clear block sent there from New York.

Acids, of course, are to be had everywhere.

Are they in the habit of using compressed hydrogen and oxygen in iron bottles in America, and, if so, could I borrow such bottles?

I am taking one screen with me, but I shall sometimes require two. Is such a thing to be borrowed?

Now, like a good fellow, answer these questions within twenty-four hours, and oblige Yours, ever faithfully, John Tyndall.

And again:

Folkestone, *September 19, 1872.*

My Dear Youmans: . . . I hope they have clear ice in Boston, also nitric and sulphuric acid; if not, I must stock myself from New York. I have written a line to Dr. Draper on this point, but I should be truly thankful to you if you would make this point out for me, and if the acid is not to be had at Boston send there a carboy of nitric and one of sulphuric acid.

I am quite shocked at the mass of apparatus I have collected round me. Still I thought it best to take light apparatus—batteries, electric lamps, and costly optical apparatus—with me, having just given the experiments with them here.

Yours ever, John Tyndall.

Prof. Tyndall arrived in October, and began his work at once by giving the Lowell lectures in Boston. Then followed courses in Philadelphia, Baltimore, and Washington.

Of his Boston lectures he says:

Boston, *October 24, 1872.*

My Dear Youmans: The hall of the Lowell still continues crowded, but I shoot above their heads sometimes.

In fact, this is my difficulty. I do not know the scientific level of my audience.

Still the people are most kind and attentive, and the newspapers, I believe, are very civil.

I go to Niagara next week, so that the fortnight will be one of relaxation in part and in part of preparation.

I have pledged myself to lecture in New Haven in January. They would be sorely disappointed if I did not do this. . . . I remain here till Wednesday, when I propose starting for Niagara.

The following letter gives Tyndall's first impressions of Niagara Falls:

International Hotel, Niagara Falls, *Monday morning, November 4, 1872.*

My Dear Youmans: I came here on Friday afternoon and have been active ever since. The first impression made upon me by the Falls was tame, because my point of view was not a good one; but they have grown in strength and majesty as I have seen more of them. I had a somewhat exciting day on Saturday, penetrating into unexpected regions under the Horseshoe Fall. I had a fine, strong fellow with me as guide; he had been put upon his mettle, and he led me into extraordinary places—into places, indeed, where no prudent man ought to be found. . . .

I remain here doing some work until Thursday, when I start for Philadelphia. If I find from my assistants that matters are all right in Philadelphia, I may be induced to stay till Friday. There is nothing, I suppose, to be arranged regarding New York? If there were, I could go that way and have a word with you.

I am stronger than when I came, and my work will gradually become easier to me—at least I hope so. I quitted Boston on Thursday, not completing all I wished to do, nor seeing all I wished to see. Still, my sojourn there was a most pleasant one. The only drawback was that many people—thousands I was told—wished to hear the lectures who were unable to hear them.

With kind regards to Mrs. Youmans and your sister, also to Mr. Appleton,

Believe me ever faithfully yours,

John Tyndall.

I find by contact with intelligent people here and there that you are well known in your own country and that your work is duly appreciated.

In the following letters Prof. Tyndall gives his impressions of his audiences in Philadelphia, Baltimore, and Washington:

Philadelphia, *November 23, 1872.*

My Dear Youmans: The second ordeal has been passed, and I believe successfully. The audience at first might have damped a person who reckoned on applause, for the Quaker element is strong in Philadelphia, and Quakers eschew the clapping of hands. But the attention was unflagging throughout. I drew heavily upon their patience, occupying them sometimes for nearly two hours. I did not see one yawn in the assembly, nor one mark of weariness from beginning to end.

They warmed up, moreover. and behaved very much as other Christians in the end. I hardly think any Englishman ever spoke so freely to an American audience as I did to mine last night. I repeated one of De Tocqueville's hardest sayings with reference to the poverty of their achievements in the higher walks of science. I took to pieces the claims of the so-called practical man, not attenuating his merit in the slightest, but opening to their view a region of antecedent discovery to which practical men were not contributors, but from which they

drew their supplies. I managed to say all this and a good deal more without exciting a murmur; nay, I was frequently interrupted by expressions of approval, and when I ended the burst of applause was as hearty as I have ever heard.

So this matter is past, and I am now preparing for Baltimore. I have received innumerable requests and invitations to lecture, and could I hope to be able to respond to them or any of them, I should send them to you and ask you to select from the many those that you think most suitable. But I see no hope of being able to prolong my visit beyond the end of January. I dare say I shall be pretty well used up by that time.

As regards science, the newspapers that I have glanced at here are very dull and poorly reported. Perhaps I have not seen the best of them. . . .

Always yours, JOHN TYNDALL.

BALTIMORE, *December 1, 1872.*

Nothing could be more genial and sympathetic than my reception at Baltimore. They declare the lectures entirely successful. Both at Philadelphia and here I have spoken very strongly about their duty as regards scientific investigation.

WASHINGTON, WELCKERIE HOTEL, 15TH ST., *December, 1872.*

MY DEAR YOUMANS: . . . The lectures here are going off well. Lincoln Hall is crowded, and I am assured that no such audiences ever assembled in Washington before. I was brief the first night, but gave them two hours the second night, and an hour and three quarters last night. By the way, when I came to the hall I found to my horror that I had put the wrong notes in my pocket, and so I had to speak for the hour and three quarters without once looking at a note. No sign of weariness or inattention was to be seen in the audience from first to last.

You will not forget the taking of quiet rooms for me. Expense is quite a secondary matter, so if the Brevoort be the best, please let me have rooms there. Quiet is the great thing—more precious than gold; yea, than much fine gold.

It is difficult to report these experimental lectures. Ordinary reporters can not possibly do it. Now, if you think the New York papers desire to report the lectures I might throw my notes into such a form as would help them, and let them have a copy of the notes of each lecture. What do you say to this?

I hope you are all right again. I am well aided here, and have brought a colored man from Philadelphia, who is very useful.

Always faithfully yours, JOHN TYNDALL.

Prof. Tyndall's lectures in New York were given in Cooper Institute, then one of our largest public halls. It was densely crowded throughout the course by the most intelligent people of the city and adjacent towns, who listened with close and absorbing attention. The ablest men of science and the professions, successful men of business, and cultivated ladies followed him with sustained enthusiasm, and it was felt that no such assemblages had ever before been gathered in New York. Much of this success was due to the attractiveness of the experiments, and much to the felicity of the professor's manner; but the indications of an earnest desire to comprehend the argument and get a thorough understanding of the phenomena presented were abun-

dant. The concluding part of the last lecture of the course was without experiments, and consisted of an estimate of the work of science and of the claims of original investigators. This was listened to by the vast audience present with almost breathless attention and made a profound impression.

A remarkable test of the public enthusiasm occurred on the evening of one of the lectures. During the preceding twenty-four hours the city was the scene of a raging snowstorm, a heavy body of snow falling, which was piled into drifts by the violent wind. With all his Alpine experience Tyndall spoke of this as "stupendous weather." Although it stopped snowing and the wind went down at nightfall, the horse cars were blocked and the streets were almost impassable. Tyndall, thinking there would be no audience on such a night, questioned whether it would be worth while to go to the hall, but finally decided to do so. To his astonishment and that of everybody else, the crowd was again on hand, not a seat remaining unoccupied. Prof. Tyndall afterward alluded to "that heroic audience which paid me the memorable compliment of coming to hear me on such an inclement night."

Tyndall had always said that it was not for him to exploit the United States as a lecturer for money, and that he should not take away a dollar of the profits that might accrue from his lectures. This was not generally known, and when it was publicly announced, the statement was received with a good deal of incredulity. A widely circulated weekly said "it was a pleasant story, but not exactly true. . . . After paying all expenses he will take home about fifteen thousand dollars, which on the whole is what the printers call a 'fat take' for three months' work." But the truth is that for nearly six months' labor * he did not take a dollar of his earnings above actual expenses.

The total receipts for his lectures were $23,100, made up as follows: Boston (six lectures), $1,500; Philadelphia (six lectures), $3,000; Baltimore (three lectures), $1,000; Washington (six lectures), $2,000; New York (six lectures), $8,500; Brooklyn (six lectures), $6,100; New Haven (two lectures), $1,000. After deducting expenses, $13,033 remained, and before leaving the country Prof. Tyndall placed this fund in the hands of a board of trustees consisting of Prof. Joseph Henry, Dr. E. L. Youmans, and General Hector Tyndale, with the recommendation, as expressed in his deed of trust, that they appropriate the interest of the fund in supporting or assisting to support, at such European universities as they may consider most desirable, two American pupils who may evince decided talents in physics, and who may

* This includes the time spent in preparation before leaving home.

express a determination to devote their lives to this work. "My desire would be that each pupil should spend four years at a German university, three of those to be devoted to the acquisition of knowledge, and the fourth to original investigation." The plan for carrying out this purpose was fully set forth in the deed of trust, but it did not work well in practice. Several students were aided, with satisfactory results, but the selection of young men with suitable qualifications was found to be more of a task than had been anticipated. The trustees were scattered, were busy men with little time for correspondence, and the employment of a paid secretary was deemed impracticable. As a consequence the income accrued faster than it was expended, the fund having been so well invested that in thirteen years it amounted to $32,400. Prof. Tyndall then decided to divide this sum into three equal amounts, to be given, one to Columbia College, one to Harvard University, and one to the University of Pennsylvania, for the founding of three permanent fellowships in physical science. These fellowships were designed for the benefit of students desiring to prepare themselves for the work of original research, and the incumbents might study at home or abroad, as the authorities of the respective institutions should decide.

There was a widespread feeling that in giving his genius, time, and labor to advance the cause of science in this country, Prof. Tyndall had earned the gratitude of all the friends of science and education in the country; and when it became known that he would also devote his money to the same end, this feeling was deepened and it was thought by many that there should be some form of acknowledgment of the great value of these gifts to the American public. So a meeting was called, and it was there resolved to honor Prof. Tyndall with a public banquet to give expression to the general feeling and bid him farewell. This took place the evening before his departure. About two hundred guests were present, and numerous letters were received from persons unable to attend, the list embracing the leading men of science, the professions, and public life in the country.

The following letters, written after Prof. Tyndall's return to England, and containing some interesting allusions to his American experience, may fitly close this account of his visit:

ROYAL INSTITUTION, LONDON, *March 11, 1873.*

Many thanks to you, my dear Youmans, and many thanks to the Tribune for the cordial expression of good will contained in the number which you have just sent me.

Two hundred thousand copies! It is certainly a most extraordinary phenomenon, and one which the English public will probably take to heart. Nothing could be more gratifying.

I am throwing my experiences at Niagara into a readable shape, intending to make a Friday evening lecture out of them on the 4th of April. As soon as ever the paper is ready I shall send it to you.

I have not yet got properly into harness; indeed, this is always a difficulty with me. When I get into a rut I tend to persist in it.

Had a letter yesterday from Hector. He tells me that he has forwarded the deed of trust to Prof. Henry. I did not keep a copy of it, and should like some time to have one, but there is no hurry. . . . Yours ever,

John Tyndall.

April 12, 1873.

My Dear Youmans: The "Tyndall number," as the World calls it, of The Popular Science Monthly duly reached me. I wish you had sent over a dozen of them. I took the number to Bence Jones (who to my great grief is dying) and to others. They were mightily struck by its tone, and Bence Jones predicts all manner of great things for a nation which can evoke the spirit manifested in the address of President White.

. . . I send you by this post a proof of my little paper on Niagara; it may be printed as it stands if time be an element of importance,* otherwise I am having a little map of the Falls prepared which will add to the clearness of the paper. . . .

Faithfully yours, John Tyndall.

THE PSYCHOLOGY OF A DOG.

By JOHN MONTEITH.

IN his recent work on Justice, Mr. Herbert Spencer turns a new light upon old questions in ethics, by tracing the roots of ethical principles to the animal community. There is something wonderful in the way certain animals form a society and exemplify the egoistic and altruistic sentiments of justice working in harmony. With all their selfish quarrels and contests, the compact of animals throws many an attempt at human combination into the shade.

But such co-operation by limitation and adaptation is only possible where there is power of perception, thinking, emotion, and purpose. Therefore, we must either assume or constantly prove, until demonstration is secured, that some animals, like human beings, think, reason, and feel, and execute intelligent purposes. Do they?

It is in the line of answer to this question that I introduce the subject of the following sketch, and record some careful observations I have made of the mental operations of my subhuman dog. I am unable to gratify the curiosity of the fancier touching

* This very interesting paper may be found in the third volume of The Popular Science Monthly, page 210.

the group into which Toots would be placed in a bench show. I suspect he is a somewhat mixed individual. He has the pointed nose, large brain-capsule, small drooping ears, and rough coat of the collie, with the short legs of the dachshund, and weighs about ten pounds. His mother was left by an English gentleman in charge of a scissors-grinder in San Diego. She was stone-blind. Her most remarkable feat was a return to her home by the lead of her nose, after having been transported to a place six miles away.

The mental development of this dog so closely resembles the unfolding of the human intellect during infancy, that it will be well to bring the two sets of phenomena into comparison. Let us break the thread of this narrative long enough to refer to some mental characteristics of the baby.

A very old objection to the possession, by animals, of mind higher than that manifested in instinct is founded in an equally old fallacy, that thinking is impossible separate from an acquaintance with the language of speech. Particularly is it urged that general ideas, or concepts, are impossible without words to represent them. If we think only in words, then dogs, who have no words, can not think. Even what we call memory in animals has been restricted to mere "association" by those orthodox philosophers from whom some of us have learned our lessons. It has not been without a struggle against prejudice that we are able to give the dog his due.

Prof. Preyer, in his excellent work on The Development of the Intellect, has, to my thought, proved conclusively that the baby, even before it has learned to speak, thinks and forms general ideas. By carefully registered observations, extending through a period of forty months of infant life, the Jena psychologist finds that, so early as the second month, the baby begins the "association of memory-images." The possession of this primitive faculty is proved not only by many examples of infants who in due time learn to speak, but by the most remarkable practical demonstration in the development of deaf-mutes.

Nothing further could be desired in the way of positive proof of the power to generalize, in the first years of life, than that the deaf-mute expresses the concept "red" by touching his red lips, and then pointing to the redness of the sunset sky. From a wide induction of such facts, Prof. Preyer safely concludes that "many concepts are, without any learning of words whatever, plainly expressed and logically combined with one another, and their correctness is proved by the conduct of any and every untaught child born deaf." And he further sums up his case by declaring that "it was not language that generated the intellect; it is the intellect that formerly invented language; and even now the newborn

human being brings into the world far more intellect than talent for language."

We may now proceed with Toots, since we have found for him common footing with the speechless human baby. The necessity of words to thinking will not be an *a priori* bar to the proper interpretation of his acts. Mere tricks acquired by dogs are of small value for our purpose, since they may be referred to reflex action. Our concern is rather with those spontaneous and self-directed acts of perception, adaptation, combination, and invention which can not be performed without the exercise of genuine intellectual power. At an early period Toots discovered an instinctive hostility to mice, moles, and black cats. His puppyhood was passed in company with a gray kitten, whom he treated with respect and affection, never failing to impress a kiss on its nose when morning came, or after temporary separation. His association of mice, moles, and black cats, and his discrimination in favor of light-colored cats, suggest a perception of color, if not a concept, which his actions have rendered unmistakable. I took him to the house of a neighbor one day, where he fell in with a litter of white-and-gray kittens, entirely strange to him, and he treated them with the utmost kindness. A day or two afterward he was introduced to a litter of black kittens, when, had he been permitted, he would have torn them in pieces. In this idea of "black" it will hardly be claimed that Toots has an abstract concept of color, but has not he a vague concept such as a baby has of "red," not redness? Otherwise, why is it that he entertains an equally intense aversion to black dogs?

The observing powers of this witty animal, and the resulting inventions and devices, have experienced spontaneous development in company with his human friends. He possesses in a rare degree the power of laughing, or, more correctly, of smiling. In a high state of pleasurable emotion he parts his lips, shows his teeth, and wrinkles the skin of his cheeks, so as to leave a corrugated appearance, like the permanent expression of the nose in the ribbed-nose or mandrill baboon. He reserves this laugh for his friends, however, when he knows that they are returning from an absence of considerable length, and never bestows it for a brief separation, unless called upon to laugh. His sign and vocal language is of his own adaptation. For a drink of water he has one combination; another for a request to be let out of the house, and still a different one to pass out at the gate into the street. He instantly observes any change in the dress of his three mistresses, which change he assumes as a preparation for an outing, and makes a corresponding request. The putting on of a skullcap by his master brings from him a mild petition to go out into the yard; but when the tall hat appears, and a cane in hand, he runs

through his extended vocabulary of freedom, for this means a walk abroad. Are not these acts precisely those of the baby during the primitive period of its thinking life? And are they not due to a mental process which in a child we always ascribe to thinking?

Toots's perception of ideas, even thoughts, conveyed in sentences uttered in ordinary conversation, surpasses anything I have ever observed in dogs, except in Scotch collies. If, in the course of ordinary family chat, the question is interpolated, "Do you want to go out?" he bounds to his feet; if in the same tone he is told, "You can not go out," he takes his disappointment without further demonstration, though no other words or gestures of command are added. Even while asleep, if the word "cat" is used in the current of conversation, he remains undisturbed; but utter the combination "black cat," and he rushes to the window to take an observation. The examples thus far given can not be referred to automatic or reflex action; they belong to the operation of cerebration, and involve ideation, classification, and judgment—in other words, thinking. At least such would be the conclusion were they the acts of a two-year-old baby.

Very early in his history Toots was taught to sit on his haunches, receiving bits of food as a reward for the performance. It was observed that he spontaneously raised his hands, as an additional expression of desire. This act was encouraged and developed by taking hold of his arms and waving them vertically, until the whole combined action became habitual, and was rendered in answer to the command, "Wave your hands!" After a long period of practice in sitting posture with hand-waving, under various circumstances and in most fascinating fashion, he disclosed the power of imitation. When held upright in the arms of another, and when already satisfied with food, I waved my hands before him, and he at once copied the same motion, and is always ready to do so in answer to this gesture.

Here appears to be a case of imitation, pure and simple, that calls for a reasonable explanation. Prof. Preyer says: "In order to imitate, one must first perceive through the senses; secondly, have an idea of what has been perceived; thirdly, execute a movement correspondent to the idea." * And further, it may be added, since a volition is involved, there must be a consciousness of self, or a formation of the concept "I." All this is granted in the case of a child; why not also in the case of a dog?

Scarcely anything is lacking in the mental furniture of this psychological dog to make him the equal of a baby two years old, except thinking in words; and who can prove that he is destitute

* The Senses and the Will, p. 282.

of this faculty, although not possessing articulate speech? The other evening, while I was giving my plants a drink, he came to me several times, asking to have the gate opened. Not caring to lay down the hose, I paid little heed to his teasings, and he determined to compass his purpose in another way. To the front door he went, and, pressing it, found it not latched, but requiring some force to throw it open. Then he backed out the full width of the veranda, and running, threw his weight so violently against the door as to drive it open. Very soon he reappeared with his mistress, to whom he had made his supplication, and she, without knowing of his failure with me, opened the gate and gave the little fellow his coveted freedom.

It should be explained, in regard to the wit shown in opening a heavy or sticking door, that Toots acquired his experience with a fly door closed by the reaction of a spring. He found by experiments that if with his fore paws he pressed this door open just far enough to emit his body, it would spring to and pinch his tail; and that by retreating and running the whole length of a small entry he could impart momentum enough to open the door wide and thus clear his tail, at the same time letting out a dependent companion. This act, I am inclined to think, is a little smarter than is usual in a two-year-old child.

The skill thus acquired is regularly applied by Toots in opening the door of the kitchen, in which his bed is made, when he proceeds with the first morning sunbeam to visit his friends in the sleeping apartments of the house. The door is closed but is not latched, to enable the dog to open it without help. Even in this condition it is moved with difficulty, owing to its friction on the sill—a difficulty intentionally allowed to remain for the purposes of my experiments.

The first effort of Toots is to press upon the door, to find whether it is fastened. As will be seen, he has come to apply this test as the result of his own experience. If the door is unlatched, he goes to the opposite side of the room and runs, throwing himself against the panels with the whole weight of his body. This act he repeats five times, after each impact retreating to the opposite side of the room to get a fresh start. With the sixth attack the passage is forced, and he scampers away with his companion, a dog with no wit at all, and is happy. More recently he has found that he can decide whether the door is fastened or not by quietly pressing his fore paws against it. Before he had adopted this test, on one night I fastened the door. He pounded it with his running catapult precisely six times; then gave up and cried for help, which was ready at hand. Such repetition of an adaptive act requires no analysis to make its psychological value apparent.

I have recorded another still more interesting act in the comedy of the kitchen door, which act raises the question whether animals are capable of emotions of a religious nature. Romanes claims to have proved that some animals exercise all the human emotions, "with the exception of those which refer to religion, moral sense, and perception of the sublime." * On the other hand, Mr. John Fiske makes a category for Toots. In discussing the "primeval ghost-world," he quotes from Nature as follows: "A Skye terrier accustomed to sit on his haunches when wanting favors from his master would also sit up before the mantelpiece before his rubber ball. This illustrates Auguste Comte's remark that dogs, apes, and elephants may have a few fetichistic notions." †

It is a habit of Toots, when alone and occasion requires, to perform his sitting and hand-waving supplications to inanimate things as if they were capable of volition. He has been discovered thus paying his addresses to a rubber doll, beseeching it to descend from the mantelpiece for his benefit. But as to rubber playthings, there is reason to believe that he conceives them to possess real life on account of the resumption of their form by elastic reaction after they are pressed. The same address, however, is made by him to a door he can not open, or to a glass of water he can not reach or ought not to have without asking, when no human friend is present to serve him.

So also when he failed to force open the kitchen door that was fastened, there followed his last effort a silence that led me to conclude it was the little fellow's moment of prayer. Accordingly, at the right instant, I thrust open the door, when I found that he had been sitting up before the unyielding object and waving his suppliant hands with a genuine earnestness that would shame the hollow formality of many a human worshiper.

The question naturally arises, Does Toots believe in ghosts? And, if so, have we not found in him the evidence of an incipient fetichism, an inspiration of rude religious emotion and a glimmering perception of the sublime?

From observations made at two Prussian stations and Teneriffe in 1889, 1890, and 1891, showing slight and continuous changes of position of the plane of the horizon, Dr. von Rebeur Paschnitz has concluded that the relatively rigid surface of the earth is subject to a movement of rising and falling like the ocean movement that produces the tides. The amplitude of the observations is very slight, but the apparatus used made it clearly perceptible. The direction of the plumb line also points to a daily disturbance, which is attributed, in conjecture, to solar radiation. A third kind of movement may be referred to distant earthquakes.

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* Mental Evolution of Man.

† Myths and Myth Makers.

SUPERSTITIONS OF THE FRENCH CANADIANS.

By Miss BLANCHE L. MACDONELL.

THE folklore of Canada is the more interesting that it has its origin in various sources. The Canadian transported with him from fruitful Normandy, from poetical and superstitious Brittany, a wealth of popular myths, traditions, legends, and beliefs which are almost as firmly held in French Canada of to-day as ever they were in the ancient days of faith. Civilization has scarcely invaded the sanctity of earnest faith, or broken its spell.

In the legendary lore of Canada the devil plays a prominent part. He does not appear as the strong angel, who fell through pride, the enemy of God, but as the mediæval devil of monkish legend, the petty persecutor of man. In the rural districts of Canada, Satan is supposed to be very active. His company may be looked for on all occasions. The accidental appearance of a little child in the room often betrays the presence of the evil spirit, as the poor innocent is sure to bewail itself vigorously. The Prince of Darkness may be met at a ball, in the guise of a handsome young man who excels all the rustic gallants in appearance. He wears gloves to conceal his claws, and disregards the trammels of conventionality by keeping his hat on his head to hide his horns. He selects the prettiest girl in the room as his partner, but his choice is usually the village coquette, whose vanity or levity has exposed her to the evil influence. In the midst of the gayety a piercing cry is heard. A strong odor of brimstone becomes perceptible, and the attractive cavalier is wafted out of the window, carrying with him some useful domestic utensil, as, for instance, a stove or the frying pan. The girl may escape with a sharp scratch of a claw, particularly if she should happen to wear a cross or a crucifix. Canadian rustics never answer "*Entrez*," when a knock is heard at the door; they invariably respond "*Ouvrez.*" This is founded upon an old legend of a young woman who replied "*Entrez*" to such a summons, when the devil came in and carried her off.

When one is starting in a hurry to bring the priest to the sick, the devil is stimulated to the most lively activity, for then it is the question of the loss and gain of a soul. On such occasions an endless variety of the most unforeseen accidents are sure to happen. The horses are found unharnessed, or the harness breaks without any reason, and strange lights flash before the horses' eyes. Prudent persons guard against such contingencies by providing themselves with two vehicles; then, if an accident happens to one, the other remains available.

The werewolf legend constitutes one of the most somber of

the traditionary beliefs existing in French Canada. The story of a human being assuming a wolf's shape is certainly one of the most generally diffused throughout the world, and the werewolf story comes down to us from old Roman times. The French Canadian believes that if a person does not partake of the sacrament for seven years, he will turn into a *loup-garou*—a shapeless animal without head or limbs; the *loup-garou* might also appropriate the form of a wild cat, a hare, a fox, or even a black hen, but at night he was obliged to range through woods and desert places. At dead of night the *loup-garou* steals from his bed; climbing the highest tree in the neighborhood, he hides in its branches, and is instantly transformed into bestial shape. He is endowed with supernatural speed and strength. A fierce creature, with appetites exaggerating those of the animal he resembles, his especial delight is in slaughtering and devouring little children. When he returns to human semblance he may be recognized by his excessive leanness, wild eyes, and haggard countenance. In order to regain his estate of humanity, it is necessary that the blood of the monster should be shed. This kindly office being performed by a friend, a complete restoration results.

The wandering Jew legend in various forms was also very popular in Canada. In many parts of the country cats of three colors were considered lucky, therefore the fortunate possessor of a puss mottled with black, white, and gray should preserve the animal carefully. When a Canadian lumberman is sufficiently fortunate to shoot a deer, he wraps himself at night in the skin, in order to keep off witches.

The souls of the lost, or spirits in purgatory, naturally occupied a prominent position in Canadian folklore. The dead frequently returned to the world; among old-fashioned persons there were few who had not held converse with a spirit or *revenant.* In punishment for sin, the dead were often detained on the scene of their past misdeeds. One dead person could not help or relieve another; the wrong committed on earth could only be righted by the intervention of a living being. The evil spirits were unable to cross the blessed waters of the river St. Lawrence without the help of a Christian. These haunting spirits were numerous, and of various descriptions.

The aurora borealis, called *les marionnettes, les éclairons, les lustrions,* are supposed to be lost souls. It is a common habit among the country people to sing aloud to keep off evil spirits—as they express it, "*Lorsqu'ils ne sont pas trop assurés.*" They believe that the sound of an instrument, or the human voice raised in song, will cause the *marionnettes* to dance. However, dire misfortune threatens the reckless being who adopts this method of amusing himself: unless the precaution is taken of touching him

in time with a palm that has been blessed, he gradually yields to a weird fascination, his eyes dilate, his voice grows feeble, and before morning dawns his body lies stiff and stark in death, while his soul has flown to join in the giddy whirl of *les lustrions*.

Fireflies, known as *feu-follets*, called by country people *fi-follets*, are also considered to be lost souls, whose goblin lights lure the unwary to destruction; a sad prerogative possessed by fireflies in common with other lights of the century—less brilliant, perhaps, but whose seductions are quite as much to be dreaded. A simple charm will curb the malicious designs of these airy, glittering imps. If the object of their persecution can retain sufficient presence of mind to thrust either a needle or a sharp knife into the nearest fence, the *fi-follet* is obliged to stop short in his course. One of two things must then happen: either the *fi-follet* will impale himself upon the sharp instrument, and thus find deliverance; or else he will exhaust himself in frantic efforts to pass through the eye of the needle, an attempt which proves quite as difficult to the fantastic spirit as to the most substantial of mortals; this gives the traveler time to seek the shelter of a dwelling.

The *Lutin* is a tricky spirit, delighting in mischief. How often may it happen that, on entering his stable in the morning, the *habitant* finds his best horses exhausted! One must be stupid indeed not to guess that this is a trick played by Lutin, who enjoys a ride at other people's expense, and is not at all likely to spare the animals of which he takes possession. A remedy for this imposition exists. Lutin is most orderly in all his ways and methods, and is forced to leave everything in its place exactly as he found it. To prevent the horses from being taken out, it is only necessary to scatter a quart of bran before the stable door. The imp will be obliged to step on the bran, the grains of which will naturally become disarranged by the pressure of his footsteps. In scrupulous fulfillment of his obligation, he must replace them one by one; the night passes in the fulfillment of this tedious task, and, when once morning dawns, farewell to Lutin's hope of a gallop.

The early French missionaries ascribed a very diabolical character to the sorcery practiced by the Indians, and many traditional beliefs held by the French Canadians can be traced directly to the influence of these heathens. It is said that the taking of Canada by the English was predicted by an Indian witch many years before the event actually happened. The French believed that several different descriptions of sorcerers existed among the savages, and that various degrees of magic were practiced among them. It was always agreed that savage magic could exercise no power over a baptized Christian except when that person happened to be in a state of mortal sin. One kind of Indian wizard

was called an *adocté*—that is, one who had made a secret compact with a *mahoumet.* It is difficult to find the origin of this term, which the French colonists applied to the familiar spirits of the Indian wizards. A Canadian writer (Dr. J. C. Taché) offers the explanation that, considering the founder of Islamism the incarnation of all evil, the French applied his name, slightly altered, to these diabolical spirits. The mahoumet was a species of goblin, who devoted himself to the service of his votary on the condition that the latter should obey him in all things and should offer him frequent sacrifices. This mahoumet is described as a little man, about two feet high, having a skin gray and shining, like that of a lizard, and eyes that glowed like living coals. The *adocté* bound himself by a solemn oath, and it was only the sacraments of baptism, confession, and absolution that had power to break the compact, Treachery between the contracting parties was not rare, neither being deterred by any scrupulous delicacy from striving to outwit the other; but as the *adocté* was the slave of his tormentor, he usually got the worst of the bargain. The mahoumet counseled his *adocté*, and, when not restrained by the power of magic superior to his own, aided him in his difficulties. Feuds were frequent between these wizards; through the powers of their mahoumets they played each other many tricks. The conflicts between them might continue for a long time, but in the end one must perish. Unless a wizard abandoned his evil practices he never died a natural death.

The Canadian sailors and fisher folk have superstitions peculiar to themselves. A belief in mermaids is very general. There are certain fishes which the fisher folk never touch; for instance, a certain kind of haddock, commonly called "St. Peter's fish," which legend declares to have been the first fish taken out of the net by the apostle on the occasion of the miraculous draught of fishes. The back of the fish is said to bear in black marks the imprints of St. Peter's fingers.

The Abbé Ferland, a well-known Canadian writer, gives an account of flames which are said to be seen dancing upon the waters of the Baie de Châleurs, and which the fishermen declare are caused by the souls of sailors who have perished on that spot, and who send this weird appearance that the living may be reminded to pray for their souls. "According to the reports of those who have examined them," he observes, "they rise from the sea between Caraquet and Paspebiac. Sometimes no larger than a torch, then again like a vast conflagration, they advance, retire, rise, fall. As a boat approaches they disappear; then, as it retires, the light acquires fresh brilliancy."

The sailors and fisher folk are also firmly persuaded that Admiral Walker, with his phantom fleet, appears occasionally in the

Gulf of St. Lawrence. The sight of this weird spectacle invariably presages disaster for mariners. A very terrible shipwreck, which took place at Isle aux Œufs many years ago, was believed to have been caused by this ghostly appearance. Before it appears the sea is smooth as glass; suddenly the waters are agitated, the waves rise mountains high, rolling wildly one against another; then a vessel appears, striving against the force of the raging billows. The deck is crowded by soldiers and mariners whose ancient uniforms date from another century. On the main deck stands the commanding officer, who is pointing out the somber heights of Cape Despair to the pilot, while a beautiful woman in white draperies clings to his arm. The ship is driving straight on to Cape Despair. Then, as the shattered vessel is ingulfed, piercing cries are heard mingling with the growling of thunder and the hoarse roar of the tempest; then, abruptly as it appeared, the vision has vanished; the sunshine dimples on a sea like a mirror, and the waves ripple softly to the foot of Cape Despair.

The word *ignolée* designates both a song and a custom imported from France by our ancestors. Both flourished for many years in Canada; though now, even in the most remote country districts, they have fallen completely into disuse. M. Ampère, chairman of *le Comité de la langue, de l'histoire et des arts de la France*, calls this song "a chorus which is perhaps the only actual fragment left of the Druidical epoch." The custom is believed to have come down from the time of the Gauls, and is said to have originated in the habit practiced by the Druids of going out on New Year's eve to gather the mistletoe which clung to the oaks of their sacred forests, and the rejoicing cry uttered by the pagan priests as the hallowed plant fell beneath their golden sickles, "*Au gui, l'an neuf!*" ("Mistletoe for the New Year!").

Christianity accepted the pagan rite, and sanctified it by charity. In Canada, a party of men, called *les ignoleux*, went, on New Year's eve from house to house, collecting for the poor of the parish, or in some localities begging wax to make tapers for the altar. They sang a chorus, in which the term *ignolée* frequently occurred, the term assuming slightly differing forms according to the dialects of the various provinces of France from which the colonists had originally come, as *ignolée, guillonée, la guillone, aguilaulen*. Troops of children, shouting "*La ignolée qui vient!*" preceded the procession. A table was immediately prepared for those who cared to partake of refreshments, as well as gifts for the poor. When the *ignoleux* reached the house, they beat time upon the door with long sticks as they shouted the chorus; but they never entered until the master and mistress, or their representatives, pressed hospitality upon them. The invitation was accepted with great state and ceremony, compliments of

the season were exchanged, and the charitable donations were placed in a bag, which was emptied into a sleigh that followed the serenaders. In begging for the poor, request was always made for a chine of pork with the tail attached, called *l'échignée,* or *la chigné.* In high good humor, heralded by barking dogs and shouting children, the whole party started for the next house.

Tradition constitutes the archives of a people, the treasures of their faiths and beliefs, the landmarks of their past history. The people's superstitions are, in truth, the people's poetry—crude, grotesque, but surely most pathetic efforts to find shape and substance for images cast by their own innate emotions, fears, and aspirations. These blind searchings after truths that lie beyond the confines of the senses, and outside the domain of logic, possess a deep significance from a human as well as from a literary point of view. These strivings are themselves phenomena to be taken into account before we can solve the problem of life.

THE WANDERING JEW AT THE SALPÊTRIÈRE.

By M. HENRI COUPIN.

THERE is always something of truth in even the most confused legends. Such is the case, for example, with the widespread legend of the Wandering Jew, which seems at first sight to have been wholly invented, but which can in reality be explained by examples originating in neuropathy. A very curious essay on this subject has been recently published by Dr. Henry Meige, from which we cite a few of the facts.

The beginning of the story of the eternal traveler Cartophilus, Ahasuerus (Fig. 1), or Isaac Laquedem—according to the country in which it is told—is familiar. By the account of Matthew Paris, Cartophilus was the bearer of Pontius Pilate's pretorium. When Jesus Christ was passing through the gate, he struck him with his hand, and said: "Go on, Jesus, go faster; what are you stopping for?" Jesus, turning to him, replied, "I am going, but you shall tarry till I come again, and shall be always wandering." According to another version, Ahasuerus is a large man, with flowing hair, a Jew in nationality, a shoemaker by trade, "who was present at the death of Jesus Christ, and has continued in life ever since." Historians agree, whichever version is taken, in representing the Wandering Jew as marching hither and thither, visiting cities hastily, appearing now in Hamburg, now in Moscow, now in Paris, etc., but always with the same aspect. Painters are no less agreed in representing the portraits after a single model; whether executed at Bautzen or at Epinal, in 1600 (Fig. 2)

or in 1800, the figure is always that of a typical Jew, wearing a large cloak, with curled beard and hair, downcast eye (Fig. 3), sadly contracted brow, etc.; with differences of the secondary order, according to the locality or the imagination of the designer.

It is evident that historians and engravers have not conspired, from one end of Europe to the other, to talk about the Wandering Jew, or represent him. He has really existed, and those who talk of him do so in good faith. How then can we make the uniformity of the descriptions, that everlasting life and endless wandering, agree with the data of science? M. Meige assumes that there have been many wandering Jews, who have been taken for one and the same person, because they usually have the same general appearance and the same manner. These persons have been neuropathic Jews, possessed by an irresistible inclination to travel. Furthermore, such invalids still exist, and have been often seen at the Salpêtrière, attracted thither by the world-wide reputation of M. Charcot. When they are observed, even superficially, and are made to relate their history, one might really believe he had in his actual presence the hero of the well-known complaint:

FIG. 1.—AHASUERUS. Facsimile of an old German engraving of 1648. (After Champfleury.)

"There is nothing on the earth
More cruelly piteous
Than the unceasing misery
Of the poor Wandering Jew!"

From M. Meige's collection of cases let us cite that of Moser B——, called Moses, aged thirty-eight years, a Polish Jew, born at Warsaw (Fig. 4). While still a child, he was drafted by the Russian military authorities and put into a special school, where

he received a certain kind of instruction. Urged by his superiors to renounce the Jewish religion, he struggled long before deciding to deny the faith of his fathers; feeling that he was in danger of yielding, he ran away and left Russia. He was then fifteen or sixteen years old, and had no trade. From that time on he wandered from one country to another, without any fixed purpose. He married in Buda-Pesth, and lived there for some time, and had three children there. The sojourn was longer than suited his disposition, and he was continually troubled with the desire to travel. He took his family to Jerusalem, and left them there while he traveled over the world. Every five years he returned from his pilgrimage, visited his family for a few days, and then turned toward new countries. The motive of these perpetual journeys from place to place, he said, "was to find a remedy for a malady from which I have suffered since I was twenty-five years old, which

Fig. 2.—The Wandering Jew, from the oldest known engraving. (Munich Library.) (Reproduced by Champfleury.)

Fig. 3.—True Portrait of the Wandering Jew as he was seen passing through Avignon, April 22, 1784. (Sketch taken at the Bibliothèque Nationale.)

gives me no truce or rest, and concerning which I have consulted all the specialists in the world." He traveled in this way through Poland, Germany, Austria, Belgium, England, and other countries.

At last the fame of the school of the Salpêtrière drew Moses to Paris during the year 1892. He made his appearance in a shabby costume, wearing a long black frock-coat, worn and patched. His mien was that of a Polish Jew. The thin face, with hollow features, was buried in a full, untrimmed beard, curling at the sides; the thick hair fell over his ears and upon the nape of his neck in greasy ringlets; his high, round forehead was crossed by deep wrinkles; his heavy eyebrows came together over the nose with two very marked folds, which gave the physiognomy an expression of pain and attention; his long, hooked nose hung over thick lips; a deep wrinkle separated it from his cheeks, and was so mobile that one never knew whether he was going to laugh or cry. He was acquainted with English, Turkish, Russian, and Hebrew, but generally spoke German. When he was admitted into M. Charcot's office, he began a long story of his troubles, and drew out a detailed list of the symptoms he felt, and began to read it. At times he would describe his sufferings with something like enthusiasm; then he would suddenly break out into an affecting lamentation over them. When a course of treatment was suggested to him, he assumed an air of attention; then, gradually, a smile would light up his face, and he would shake his head with a skeptical air, saying that he had tried all that with no success. Moses stayed a year in Paris, receiving electrical treatment; then, finding that of not much effect, he went away in search of a cure that could not be found.

Fig. 4.—Moser B——, or Moses, an Israelite, Neuropathic Wanderer.

Gottlieb M—— (Fig. 5), forty-two years old, a native of a village near Wilna, like Moses, began to travel very early, and has been a frequent visitor to the hospitals. Never finding any remedy for his ills, he passed from Russia into Germany, then into Austria, England, and France.

Fig. 5.—Gottlieb M——, an Israelite, Neuropathic Wanderer.

The history of other sufferers, in all essential features, is very like these.

If we compare the wandering neuropaths with one another and with the Wandering Jew of the legend, we find a remarkable uniformity among them. In the first place, we are struck with the common origin of the sufferers, who all seem to have come from the same source, which is situated on the borders of Germany, Poland, and Austria. All, while polyglots, speak German by preference. The Wandering Jew has the same characteristics. "Wherever he went," says a legend of 1618, "he spoke the language of the country." On the other hand, the persons who thus become wanderers, usually without apparent cause, are always Jews; they find in themselves the impulse that urges them to travel; most frequently it is the necessity of consulting a new doctor, of trying a new remedy. On the road, they live on alms; on the other hand, profiting by the solidarity which prevails between Israelites, they find in every city credit houses where they can enjoy a modest revenue that makes them eternally rich, while it leaves them eternally poor; and thereby is explained in a remarkable manner that strophe in the complaint which awakens wonder at first:

> "I have five sous in my purse,
> In that is all my means,
> And everywhere and always
> I have enough."

Like the Wandering Jew, again, these neuropathic wanderers are shabbily dressed in a great cloak or a long robe reaching nearly down to the ground. They are nearly always men thirty or forty years old, but whom we might, from the wrinkles on their faces, suppose to be double that age. Their beards are long and uncombed. The beard of the Wandering Jew is, perhaps, the most characteristic trait of his figure. The primitive painters, as our figures show, represented it with great sincerity:

> "Never was seen
> A man so bearded."

The beards seen in the most ancient engravings are as exactly as possible like those of the sufferers observed by M. Meige; they are curled in all their length or are rolled in ringlets on the sides, where they mingle with the hair, also curled.

The faces of all the neuropaths express suffering, lassitude, and despair; a meager countenance, salient cheek-bones, hollow cheeks, and wrinkled foreheads appear in all the sufferers and all the portraits.

From the pathological point of view wandering neuropaths suffer chiefly from nervous exhaustion—neurasthenia—of which they present all the physical and psychical marks. Hysteria may sometimes be added. The Wandering Jew seems likewise never to have had a firm nervous equilibrium, for every time he had occasion to speak to any one he complained of being persecuted.

Thus, after all that we have just said, the Wandering Jew still exists, and under the same form he assumed in past centuries. His figure, his costume, his manners have preserved the same characteristics through the ages. The Wandering Jew of the legend and the Wandering Jew of the clinics are one and the same type: a wandering neuropath, a perpetual pilgrim, appearing to-day, vanishing to-morrow, and followed soon by another who resembles him in all points; a third will come like his predecessors, and then a fourth, and so on. Cartophilus, Ahasuerus, Isaac Laquedem, Moser B——, etc., are children of nervous pathology. Their resemblances result from attacks of the same malady, and have an identical origin.—*Translated for The Popular Science Monthly from La Nature.*

A curious phenomenon is sometimes observed near Wetter Lake in Sweden, in the standing still of the Motala River. The flow of water ceases and the bed of the river is dried up, while the water is held back in the lake. It was formerly regarded as a miracle and portent. It is attributed by Block to a sudden sharp frost, which freezes the river to the bottom at a shallow place without allowing time for the formation of mere surface ice. An east wind and the growth of reeds near the outflow of the lake may also contribute to the stoppage.

THE SHAPE OF THE EARTH FROM A PENDULUM.

By Prof. J. H. GORE.

IT was thought that a maximum paradox was reached when the quotation *ex pede Herculem* (from the foot, Hercules) forced its way into use. Hercules, in laying out the *stadium*, the length of the running course in the Olympian games, used his foot as the unit, and made the stadium six thousand feet long. From this distance, which was preserved, Pythagoras obtained the length of the foot of Hercules, and from an arbitrary ratio between the parts of the body deduced his height, thus restoring from the foot, Hercules.

But we can now propound a greater paradox, and say from a pendulum, the earth. Not the world that one can put in a sling, but the earth's shape. This striving after the shape of the earth has occupied men's attention for centuries; to know this shape they have braved the cold within the Arctic Circle, endured the heat of the equatorial regions, and penetrated India's malarial jungles. Peaks have been climbed, deserts traversed, and hostile tribes subjugated. To the theoretical side of this problem scores of the world's most profound mathematicians have devoted their time, while the practical side has been pushed ahead by the energies of countless troops of observers, artisans, and laborers, supported by the expenditure of millions upon millions of dollars.

While this great work is going on, looking toward a solution of this problem, with staffs of specialists in sixteen nations, employing instruments most complicated and refined, making, as it appears, an onslaught on the earth itself to compel it to yield to direct measurement, it now seems that from a modified form of the device which regulates our clocks—the pendulum—we may expect the most accurate knowledge regarding the earth's shape.

When Galileo deduced from observation that a pendulum is isochronal—that is, would make all its oscillations in the same interval of time whether the arc be long or short—he did not dream that the swinging lamp in the dome of Pisa's great cathedral in the year 1583 would be the prototype of the accurate geodetic instrument of three centuries later.

If the ball of a pendulum be drawn away from the vertical and released, its first impulse is to descend perpendicularly; but being held in restraint by the string, or connecting rod, it does the next best thing, and, keeping as near to this perpendicular direction as possible, it swings down a circular arc whose center is the point of support. When the lowest point of this arc is reached, an amount of energy has been stored up and the ball ascends the other side of the arc until this supply of energy is exhausted;

then stopping for an instant the ball again descends, to ascend on the other side, thus adding oscillation to oscillation. Were it not for the resistance of the atmosphere and certain mechanical imperfections these arcs would be the same, but, what is more important, the times of oscillating are the same.

The rapidity with which the pendulum descends depends upon its length and the amount of this impulse to drop vertically. This impulse is known as *gravity*. Therefore, with a pendulum of constant length the time of oscillation will be dependent upon gravity, and thus time and gravity are determinable one in terms of the other.

Newton had shown that gravity on the earth's surface depended upon distance from the center of the earth, and also the diminishing effect of the revolution of the earth on gravity. To this theory other mathematicians made valuable contributions, notably Clairaut, who demonstrated that the relative lengths of the equatorial and polar radii could be ascertained directly from the force of gravity at the equator and at one of the poles. Then, since the gravity is obtained directly from the time in which a pendulum makes an oscillation and its length, it was necessary to simply swing a pendulum at the equator and at one of the poles to have at once the coveted ellipticity—that is, the ratio of the difference between the equatorial and polar radii to the equatorial radius.

Unfortunately, it has not been possible to swing a pendulum at one of the poles. This inability, however, is made of no moment by a law which gives the value of the polar gravity whenever the gravity of a given place is known, together with the latitude of the place.

From this it appears that the earth's figure becomes known through a determination of the length of a pendulum and the time required for it to make an oscillation at the equator (or near it) and at the pole (or as near to it as possible). If the *same* pendulum is used and the constancy of its length assured, it becomes necessary to make sure of the length of time required for an oscillation at these two places. Inasmuch as the pendulum appears to stop for an instant when it reaches the highest point in its arc, it is a difficult matter to determine with exactness the time of an oscillation; but if one counts the number of oscillations in an hour, in two hours, or in any number of hours, a simple division will give the time of one oscillation.

The figure of the earth desired is an ideal figure, such a figure as it would have if one could remove all the land now standing higher than the surface of the sea—were a sea to occupy the place of the land. Hence it is the sea-level earth whose figure we want. Newton's law of gravity would require that a pendulum, if raised

above the level of the sea, would make its oscillation in a longer time than when swinging at sea level. Therefore it is necessary to know the elevation of the station in order to ascertain the force of gravity in that latitude on the ideal earth.

If the parallels were perfect circles and if observations were absolutely correct, it would be necessary to swing a pendulum at only two points on the earth's surface in order to determine its shape. However, the results obtained by combining observations two and two are not harmonious; not only because the observations may be affected by errors, but the attraction of dense matter immediately beneath a station might seriously impair the observations made there; and as we never know the exact constitution of the earth's crust at any point, it becomes necessary to eliminate, as far as possible, this uncontrollable error by making observations at many places.

The ideal pendulum would consist of a ball of symmetrical form suspended by a wire stiff and uniform. Like all ideal conditions, these are never attained, but a close approximation is sought. In seeking rigidity the pendulum rod must be so large in cross section as to make the instrument cumbrous. This was a serious feature when, in order to avoid slips in counting, it was not thought feasible to use a pendulum that made an oscillation in less than a second of time—that is, a pendulum about thirty-nine inches long. Again, as the pendulum was provided with sharp knife-edges on opposite sides near its upper end, shaped like a V, on which it swung, the greater the weight of the pendulum the more wear there would be on these knife-edges. This becomes a serious matter, as the length of the pendulum is estimated from the line of support furnished by these same knife-edges. Then, too, the swinging of a large and heavy pendulum was liable to induce a swinging motion in its support, unless the latter were exceedingly rigid, thereby vitiating the results.

Several years ago it was realized that the resistance of the atmosphere would vary with different conditions of moisture and density, and hence retard the pendulum more at some times than at others, more at some elevations than at others. Therefore it seemed necessary, in the absence of any well-accepted correction for these hurtful resistances, to swing the pendulum always under the same atmospheric pressure and surrounded by similar conditions as to moisture. This could be done only by inclosing the entire pendulum in a chamber in which the air could be maintained at the same density and dryness. One can readily see how difficult this would be with an apparatus more than four feet in length and weighing many pounds.

Although the shortcomings of the ordinary pendulum forced themselves into recognition one by one, still the readiness with

which observations could be made, in comparison with direct measures of the earth, has caused it to be regarded as a most important geodetic instrument.

As early as 1735 observations were made at St. Domingo, Panama, and Quito, using a plummet suspended by a thread of the aloe; about the same time the party sent to measure an arc of the earth within the polar circle swung a pendulum within twenty-four degrees of the pole. Lacaille carried a pendulum to the Cape of Good Hope and the Isle of France, Legentil took one on his voyage to the Indian Ocean, Phipps on his voyage toward the north pole, and Malaspina while visiting the Spanish possession in the Western hemisphere. Biot, Arago, and Borda were perfecting the pendulum and measuring gravity at different places in France; the labors of Ross, Kater, Foster, and Sabine were giving to England the supremacy in matters pertaining to gravity determinations; while Bessel, in Germany, was busy investigating corrections for the weight of air by swinging a pendulum in a vacuum, then in gases of known elasticity.

The French, not willing to follow in the lead of others, sent out expeditions under Freycinet and Duperrey, who brought back pendulum data that still find their places in the discussion of the earth's figure. These were followed up by Sawitsch in Russia, Plantamour in Switzerland, Basevi in India, and Peirce in the United States.

During all this time attention was given chiefly toward perfecting the mechanism of the pendulum without changing materially its form. It became heavier rather than lighter; the supports were correspondingly more cumbersome; the knife-edges subjected, because of increased weight, to greater danger of dulling, while theory was continually devising corrections because of atmospheric pressure and viscosity. The defects in structure took on an exaggerated magnitude, and the chance to discover absolute corrections appeared hopeless when the rapid advance in physical science set a limit of error to direct observation, and it looked almost as if the pendulum would be a doomed instrument of investigation.

Just in this emergency Superintendent Mendenhall, of the United States Coast and Geodetic Survey, called to his aid his experienced assistants to so modify the form of the pendulum as to bring it into its proper sphere of usefulness. Skilled as a physicist, it was not possible for him to waste time stumbling through the mistakes detected by the experience of others. He started anew where they had stopped.

The first point reached was the important one. By an application of the principle of coincidences first employed by Foucault in 1850 in determining the velocity of light, it became possible to as-

certain the number of oscillations made by a pendulum within an interval of several minutes without counting them. This at once suggested that the danger of making a slip in counting the oscillations, should they be as frequent as two in a second, might be avoided, and thus a short or half-second's pendulum be employed. This shortening resulted, of course, in a lightening, and each ounce of diminution added to the safety of the knife-edge, thereby contributing to the permanency of the pendulum. Nor was this all: the parts now became of such wieldy size that the whole could be incased in a chamber sufficiently air-tight to maintain a constant atmospheric pressure either by exhausting a portion of the air near sea level or forcing air in when stations at great altitudes are occupied.

With a pendulum so compact one can visit places heretofore inaccessible with the larger forms, and require distant islands and inhospitable climes to give a voice in determining the earth's shape. Large land areas are needed for the measurement of arcs, and hence less than one fourth of the earth only is available to determine geodetically its shape. But now each party sent out on a voyage of discovery or to observe astronomic phenomena can take one of these compact pendulums along and make stations within the bounds of the three fourths so that they may not be encompassed by a figure dictated by the minority.

Now that differential methods are used almost universally—that is, comparing the times of oscillation of the *same* pendulum at different places—it is essential that the length may continue to be what it was when swinging at the base station, or station where absolute gravity had been determined. Supposing that due correction has been made for such changes in length as would be occasioned by differences of temperature, the only possibility for variation in length could come from disarrangement or wear of the knife-edge. Any chipping of this knife-edge—made of agate—could not be rectified, and dullness could not be removed without making in so doing a new pendulum, thereby destroying its differential value. In swinging, this agate V rests on a steel plane, and as this plane, forming no part of the pendulum proper, is less liable to injury or derangement, the idea occurred to the survey officers to let these parts change places. So now we have a pendulum with a slit in the upper end of its rod, having for its upper surface a plane of hard steel. This plane rests on the agate knife-edge which projects into the slit. If now the agate becomes dull or injured it can be repaired or a new one substituted, and the pendulum remain the same.

As already stated, the usual procedure has been, when observing with a pendulum, to note the number of oscillations made in a given interval of time; then, by dividing this interval by the

number, the time of one oscillation is obtained. Of course, the clock or chronometer which furnished this time might be running too fast or too slow. However, it has been customary to determine the rate of the timepiece by making an astronomic observation before swinging the pendulum and then again after. This would give the amount of time gained or lost in the interim, but does not prove that this amount, or even more, was not the change within the interval of swinging, or that the keeping of time was not perfect while the pendulum was swung, and the error occurred either before or after.

From this uncertainty arose the need to eliminate time error, and it has been most ingeniously met in the survey pendulum. Here two pendulums are employed—one at one station and one at another, connected by a telegraph wire. Each is made to record its own coincidence with a beat of one and the same chronometer, so that if the chronometer has a constant rate for a minute or two it is sufficient. The chronometer at the other station is then used to eliminate such errors as might arise in the transmission of signals. In this way the relative time of the oscillations of two pendulums is known with absolute accuracy, and from these relative times relative gravity is obtained, and from relative gravity we have relative distances to the earth's center, or the shape of the earth.

In this enlightened age it is not necessary to enumerate reasons why we should know the shape of the earth. It enters as a potent factor in astronomic computations; it is indispensable in map-making, and no boundary line can be drawn without its aid. Besides carrying on the special cartographic functions prescribed for it by law, the United States Coast and Geodetic Survey has lost no opportunity to improve our knowledge of this important factor, and under no *régime* has the survey so completely filled this dual purpose as under the superintendency of Prof. Mendenhall.

We do not measure the earth with a span, but with a pendulum one span in length we find its shape.

Three hundred tombs, apparently dating from the period of the Huns, were discovered last year in the commune of Cika, in Hungary. They contained bodies of knights in armor, with the skeletons of their horses by their sides. The faces of all were turned toward the east. The bodies were reinterred, and the articles found in the graves were sent to the museum at Buda-Pesth.

The publication of an Index to the Names and Authorities of all Known Flowering Plants and their Countries, which was contemplated by Mr. Darwin, has been undertaken at the Clarendon Press, under the direction and supervision of Sir J. D. Hooker. Part I of the work is now ready, and Part II is well advanced.

THE POSITION OF GEOLOGY.

By Prof. JOSEPH PRESTWICH, F. R. S.

THE position of geology in this country at the present time, more especially as relates to the later geological periods, is anomalous and possibly without precedent. On one side its advance is barred by the doctrine of uniformity, and on the other side by the teaching of physicists. The former requires that everything should be regulated by a martinet measure of time and change. It asserts that the vast changes on the earth's surface, effected during long geological periods, are to be *measured by the rate at which similar but minor changes are effected in the present day*, and that the agencies now modifying the surface have been alike, in every respect, in all past time. It is true that no restriction is placed on the extent of the changes, but such prolonged time is insisted on for their accomplishment as to destroy the value of the concession. Not that time is in itself a difficulty, but a time rate, assumed on very insufficient grounds, is used as a master key, whether or not it fits, to unravel all difficulties. What if it were suggested that the brick-built Pyramid of Hawâra had been laid brick by brick by a single workman? Given time, this would not be beyond the bounds of possibility. But Nature, like the Pharaohs, had greater forces at her command to do the work better and more expeditiously than is admitted by uniformitarians.

On the other side, physicists would lead us to suppose that those great movements of the earth's crust, with which we are all familiar in the form of high mountain and continental upheavals in the earlier stages of the earth's history, were impossible in those times which more immediately approached our own. They maintain that if the earth is not solid throughout, its outer crust at least must have now attained a thickness estimated to vary from eight hundred to twenty-five hundred miles, and is so rigid that we are forced to believe that for a long preceding period it must have been in a state of comparatively stable equilibrium. This, however, would have rendered the great earth movements, considered by geologists to have continued up to the threshold of our own times, impossible. And to this finding the physicists would have geological speculations conform. At the same time, judging, among other reasons, from the rate of cooling of hot solid bodies, they would assign a much shorter term to the earth's history *since it became habitable* than is compatible with the views of the uniformitarian school of geologists. The one side counts in round numbers upon some three hundred million years; the other sees no reason to go beyond fifteen to twenty million years

—a term, in our humble opinion, much more probable than the other.

On another point our two allies (allies in the sense of working at the same subject) are in irreconcilable antagonism. The physicists tell us that uniformity of action in all time is impossible, while the uniformitarians say that such a shortening of geological time as would follow on the acceptance of the physical argument is against all geological experience. Not only do these opinions clash, but those also concerning the rigidity of the earth and the thickness of its crust are widely divergent. None of these contentions can, however, be disregarded, for we must all recognize the importance of considering the question from every point of view. The argument in favor of uniformity of action has been put before us with so much skill and ability, and possessing as it does the charm of an infallible faith, that uniformitarianism has become the accepted doctrine of the dominant school of geology. Besides, within certain limits and in certain lights, the arguments of the uniformitarian and of the physicist might hold good—that is to say, if we would restrict the deductions of the former to the recent period, and could adopt the propositions of the latter. Our part, however, is to see whether their conclusions agree—not with their respective assumptions, but with the geological evidence: for no conclusions can be accepted that do not meet with the full concurrence of all the copartners interested in the result, and without respect for their mutual claims progress is not possible. The geologist must attend to the claims of the physicist, and the physicist ought not to overlook those of the geologist. How then stands the case?

With regard to the geological problem, we are told by the uniformitarians that the forces acting on the surface of the globe have been in all past times the same, both in *kind* and *degree*, as those now in operation. On those grounds they have proceeded to estimate, first, the time required for mountain and continental elevation; secondly, the rate of erosion of the valleys, and of the denudation or lowering of the land. Their conjecture is that our limited experience of two thousand to three thousand years has sufficed to furnish us with instances of all the various vicissitudes and changes that the earth has undergone during the illimitable past—a generalization incompatible with what is known of the evolution of the earth, and in contradiction to their own premises. For even geologists who recognize no change admit the original molten state of the globe. This of itself involves, in the cooling of the mass, the intervention of stresses and strains, with all their consequences, which render it inconceivable that there was nothing in all those stages of the earth's history beyond what our limited experience has brought us in contact with.

But although the assumption of the uniformitarians on the question of *degree* may be disputed, that on the question of *kind* admits of no dispute. That rivers excavate and currents distribute the excavated materials, and that the land is mobile and subject to changes of level, no one will contest. The point of contention is the *rate* at which these operations and changes proceeded formerly as compared with the rate at the present day. The many observations made on the erosive and transporting power of rivers, and on the movements and waste of the land, are admirable in so far as they apply to the silting up of ports, the recession of the coast, and the reclamation of marsh lands; but, though valuable to the engineer, they are misleading to the geologist. They furnish him, it is true, with standards applicable to present changes, and indicate *the method* in which the erosive power of the rivers and seas has acted in all time, but they give no measure of the *amount and rate of work* they did at different periods. Nevertheless, knowing what at present is accomplished by their means, it is reasonable to judge, by ascertaining what their agency accomplished in former days, of the difference in the forces in operation at the several periods. Those forces have to be estimated by the work done in the past, and not by any fixed rate founded upon present work.

Few geologists would, we presume, contest this position; notstanding which, and though many now profess a modified uniformitarianism, the old lines of argument still, with few exceptions, prevail, and the concessions made are more apparent than real, or are of little value. In our opinion, no partial concession can be entertained on the question of *degree*. It must be an unconditional surrender; for, in contradistinction to *method*, or manner, where we are on common ground, no common scale on the question of degree is possible in judging of the past by comparison with the present.

As an example of the present position, we may take one argument as presented by the advocates of the uniformitarian school. The observations on the transporting power of the large rivers of the world have shown that the quantity of sediment carried down by them to the sea is, according to one of their estimates, such as would suffice to lower the level of the land about one foot in six thousand years, or about a thousand feet in six million years. Exception might be taken to this estimate in that no account is taken of the calcareous matter removed in solution, which, in fact, is not far from the quantity of insoluble matter carried down mechanically. Let that pass. This measure, or one approximate to it, has been very generally accepted, and is in common use. Hence those geologists, proceeding solely on the assumed postulate, and not attaching due weight to other con-

siderations, have, it seems to us, placed the later Quaternary times at far too great a distance from the present. In the same way, the rate at which the elevation of the land took place having been estimated on the mean of two and a half feet in a century, would, if that scale were accepted, manifestly push back to a very remote distance even later geological changes.

The importance of determining these points more accurately became more evident when it was discovered that man existed with the extinct mammalia; and therefore upon the solution of the time-rate problem depended the determination of the antiquity of man upon the earth. Various have been the attempts since made; but, as they have almost all been made upon measurements based on the above-named scales, they necessarily involved a very free use of time. For long, geologists had held to the belief, prevailing half a century ago, that man could not have existed on the earth for more than five to six thousand years. When evidence was given, and at last accepted, to prove a higher antiquity, the uniformitarians were placed in the difficulty of proving too little or too much. If they adopted a short chronology, it would clash with the corner stone of their belief as to the age of the Quaternary deposits; if, on the other hand, they retained their belief in the great length of time they held to be necessary for the formation of the post or later glacial deposits, they would have to assign to man an antiquity which would clash sorely not only with their own previous belief, but also with that held on various grounds by other geologists and anthropologists.

The fetich of uniformity prevailed, the uniformitarians made *volte-face* to their former contention, and hesitated not to claim for man an antiquity going on for a million years. One old friend of ours, in a public lecture, even put in a claim for two millions, heedless of the cries of his unprepared audience to remind him of the rights of Adam. At a loss to prove their case by independent geological evidence, they found an unexpected ally in a novel and ingenious astronomical hypothesis, which apart from its connection with geology we will not contest. The object of the hypothesis was to show that there had been cycles, in which at times the position of the earth in its orbit was such as would cause a great lowering of the terrestrial temperature and give rise to recurring glacial periods. Here were offered the definite measures that geology failed to furnish, and which tallied too well with the time needed by the uniformitarians to be neglected. It was therefore eagerly adopted, and has since been prominent in geological literature. That the hypothesis, however, is not in accordance with the facts of geology has been abundantly shown both in America and in this country; never-

theless the belief prevails. The result is that, as the last of these astronomical periods was calculated to have commenced two hundred and fifty thousand years and to have ended eighty thousand years ago, these numbers have become stereotyped as those of the beginning and the end of the Glacial period.

The able author of this hypothesis, in his attempt to reconcile geological and astronomical time, built his geological argument upon the rate of erosion of rivers at the present time, as held by the uniformitarian. Nevertheless, an observation of his own, that must be indorsed by all geologists, whatsoever their creed, shows the fallacy of adopting the rates of the present day as measures for the past, for he remarks: "*If the rate of denudation be at present so great, what must it have been during the Glacial period? It must have been something enormous.*" Very true, yet the argument proceeds as before. With the admission here made, how is it possible to adopt a scale admitted by its advocate to be subject to such variation? Its retention only serves to divert the real issue and stay inquiry.

Another objection to this chronology is that it fixes the date of the disappearance of palæolithic man and the Quaternary fauna at a distance of eighty thousand years from our own times. Of these eighty thousand years, we can account for ten or twelve thousand during which neolithic and recent man has been in occupation of the land; but this leaves some seventy thousand years unaccounted for. Unable satisfactorily to show on geological grounds the need of so great an interval between the end of the Quaternary period and the present time, the uniformitarians find a more colorable defense on biological grounds. They point, in a manner we do not quite understand, to the circumstance that with the close of the Post-glacial period a number of the animals then living disappear from the scene, and contend that for the dying-out of so many species long ages must have been required. Had they been able to show the working of evolution in the coming in of new species by descent from the extinct species, or of change in the contemporary species still living, their argument could not be gainsaid. But there is no question of evolution. The mammoth and woolly rhinoceros disappeared for good; the reindeer, musk ox, and glutton were driven to northern latitudes, and there still survive unchanged; while the horse, ox, red deer, wolf, fox, badger, hare, and others remain on with us without variation of species. The extraordinary change of climate which then took place is quite sufficient to account for such changes as these, which are chiefly of those of faunal distribution, having been effected in a measurable length of time, instead of needing the vastly long period mentioned. This length of time could hardly have failed to involve more extensive changes

in the species, even without the aid of the physical changes which then took place, than are apparent in the species now existing. There is, in fact, no sufficient evidence either geological or biological to show the need of the long interval assumed. On the contrary, there is every reason to believe that it did not exist, but that palæolithic man and his companions came down to within some ten to twelve thousand years of our times. We can not suppose that either man or geological work would have remained stationary during seventy thousand years, and yet that is the conclusion we should be driven to adopt. Are we to be debarred from pursuing these inquiries by a hypothesis having no better foundation, and involving such unquestionable difficulties?

Another barrier to inquiry is the postulate which would fix the rate of upheaval of the land during geological periods upon observations based—not upon the experience of even two or three thousand years—but upon observations which do not extend beyond two centuries. These observations have shown, as put by uniformitarians, that the *mean* rate of elevation of the coasts of Norway and Sweden has been during that time two and a half feet in a century, and this scale has been accepted and employed unhesitatingly as a safe and sure basis for calculation of geological time. The determination of a secular rise of the land is of itself an interesting fact, as settling the question of a retained mobility in the earth's crust; but it is quite insufficient, even if it were applicable, to establish a definite rate, not only for the past but even for the present. It is not a mean rate that is wanted. No upheaval can be otherwise than local and graduated. The extremes are what is needful. No engineer would take the mean delivery of a river as the measure to be depended upon for a water supply. It is the limit in both directions, or the minimum and maximum quantities, that are essential. To know what earth movements can still effect, we should at least take the maximum rate, which amounts in the above case, at the North Cape, to five feet in the century, or double the measure of the mean adopted by uniformitarians.

If also, in calculating the present rate of elevation of the land, the mean rate along the whole length of the axis is adopted, the same rule should at least be applied to elevations of past periods, and the time should not be estimated by the height of any one point, as that may prove to be more or less in excess of the mean. Thus, for example, the Westleton marine shingle is found in Buckinghamshire at a height of six hundred feet. Estimating this upheaval at the rate of two and a half feet in a century, the uniformitarian would put in a claim for twenty-four thousand years. But this bed, as it trends eastward, is met with at gradually lower levels, until in Suffolk it falls to the sea level. A

mean of three hundred feet should therefore be taken, with a corresponding shorter time-term of twelve thousand years; or are we to ignore any interval of time and to look only at the beds on the coast where they are consecutive? From every point of view such estimates must be worthless.

More than this, the very leaders of the belief that the average rate of motion does not exceed that above named allow that "*the average rate proposed is a purely arbitrary and conjectural one.*" It is admitted also that it is not improbable that during the last four hundred years there has been a still faster rate in high northern latitudes. Not only, however, is the half measure adopted, but the warning that higher measures exist is neglected. When therefore the mean is applied to determine the length of time required to effect such elevations as that of the marine shell bed on Moel Tryfaen, fourteen hundred feet above sea level and of late Quaternary age, uniformitarians are obliged to ask for a term of fifty-six thousand if not eighty thousand years. Should the case of Moel Tryfaen be objected to as uncertain, there are still the unquestioned raised beaches of Norway and Sweden, which are from two hundred to six hundred feet above the sea level, and of still more recent date. These, on the same estimate, would have taken for their upheaval some eight thousand to twenty-four thousand years. We need not, however, pursue this subject further. The very admissions of the advocates of the two above-named measures of time, based upon present rates of denudation and of elevation, show how untenable their conclusions are.

Such observations, howsoever useful and suggestive, are in fact futile so far as regards their application to former rates of upheaval, and needlessly play with time. If we could suppose that the causes which produced those movements had always acted with the same degree of energy, the reasoning would hold good; but, as that regularity depends upon the stresses to which the earth's crust has been exposed at any particular time, the effects must have varied in proportion as the stresses varied. With a cooling globe it could not have been otherwise. What those movements of the past were, and what their duration, must therefore be judged of by other circumstances and on surer data.

We trust we have now said enough to show upon how insecure a basis the uniformitarian measures of time and change stand. They have probably done more to impede the exercise of free inquiry and discussion than any of the catastrophic theories which formerly prevailed. The latter found their own cure in the more accurate observation of geological phenomena and the progress of the collateral sciences; but the former hedge us in by

dogmas which forbid any interpretation of the phenomena other than that of fixed rules which are more worthy of the sixteenth than of the nineteenth century. Instead of weighing the evidence and following up the consequences that should ensue from the assumption, too many attempts have been made—not unnaturally by those who hold this faith—to adjust the evidence to the assumption. The result has been strained interpretations framed to meet one point, but without sufficient regard for the others. We repeat that we would not for a moment contend that the forces of erosion, the modes of sedimentation, and the methods of motion, are not the same in *kind* as they have ever been, but we can never admit that they have always been the same in *degree*. The physical laws are permanent; but the effects are conditional and changing, in accordance with the conditions under which the law is exhibited.

Such are the barriers which seem to us seriously to retard the advance in one direction of an important branch of theoretical geology, while in another it is fronted by the stern rules of an apparently definite calculation.

We must ask to be forgiven if we can not accept the conclusions of physicists respecting the extreme rigidity of the earth and the immobility of the crust as conclusive. That the rigidity is now very great—as great, we will admit for argument's sake, as if the globe were of glass or steel—may be as asserted, but that conclusion can only be accepted in so far as it conforms to the facts of geology. Were the data on which the conclusion is based fixed and positive, like those on which the laws of gravitation and light are established, there would be nothing for the geologist to do but to bow to the decision of the physicist, and, if possible, revise his work. But in this case the tidal observations, on which the calculations of rigidity are mainly based, are of such extreme delicacy that, failing as the hypothesis does to satisfy the requirements of geology, the geologist may be excused for his dissent, pending further inquiry. Should this tend to confirm the extreme rigidity of the globe, we must seek for some explanation of earth movements consistent with that rigidity. It is indisputable that up to the latest geological period—that touching on our own times—the mobility of the crust was very considerable, for the raised beaches of Europe and of the Mediterranean prove conclusively that in that period extensive tracts were raised at intervals to heights of from ten to six hundred feet or more above their former levels. It is difficult to conceive that a globe, of which the crust was then so mobile, could have acquired, in the comparatively short interval between the latest of the beaches and our own time, so great a rigidity as to be practically immobile.

For similar reasons the conjoint conclusion that the crust of

the earth is not less than from a thousand to twenty-five hundred miles thick is open to question. We can not imagine that a crust of that enormous thickness could, in such recent geological times, have possessed so great a flexibility as is indicated by the movements we have referred to. Independently of that improbability, there are certain geological facts which are inexplicable on that assumption. Volcanic phenomena would be unintelligible; for vents traversing that thickness of solid rock could hardly be kept open owing to the cooling which the lava in its ascent would undergo. The rock fragments ejected during explosions are also those of rocks which lie at no great depth, while, with the increase of temperature in descending beneath the surface, there is every reason to suppose that at a depth to be measured by tens, and not by hundreds of miles, the immediate underlying magma at least is in a state of plasticity such as would allow of comparatively free movements of the crust. Again, surely, if the crust were so thick, we might expect to find, when that crust was broken and its edges thrust up by compression or protrusion of the igneous rocks, that some indications of that enormous thickness should be exhibited; but none such are forthcoming. Whatever may be the state of the nucleus, there is nothing geologically to indicate, as some physicists also have contended on other grounds, that the outer crust of the earth is more than from about twenty to thirty miles thick. The effective rigidity will therefore, if it be necessary, have to be explained in some other manner than that of a comparatively solid globe or of a crust of enormous thickness.

We are thus brought face to face with apparently irreconcilable opinions. That they admit of adjustment there can be no doubt, but it must be by mutual understanding. How it is to be effected is a problem for the future.

These, briefly, are the barriers which restrict inquiry on many important questions. On the side of the uniformitarians, it is assumed that every position must be reduced to a fixed measure—where fixity is not possible—of time and speed; and, on that of the physicists, geologists are gently reminded that the subject is outside their immediate sphere of inquiry, in a way somewhat suggestive of "the closure."

It would be an unfortunate day for any science to have free discussion and inquiry barred by assumed postulates, and not by the ordinary rules of evidence as established by the facts, however divergent the conclusions to which those facts lead may be from the prevailing belief. In any case it must be remembered that no hypothesis can be true which does not satisfy the conditions both of the geological phenomena and of the physical laws.

The foregoing remarks are intended to apply mainly to questions connected with the more recent geological periods. The older epochs have happily been treated as beyond the barriers, and consequently have enjoyed and made good use of their greater freedom. It is to be hoped that, when the phenomena of these later periods are judged of by the evidence of facts rather than by rules, they will receive more independent interpretations—interpretations that may escape the dwarfing influence of uniformitarianism.—*Nineteenth Century.*

SKETCH OF DAVID STARR JORDAN.

By Prof. MELVILLE B. ANDERSON.

DAVID STARR JORDAN was born in 1851, at Gainesville, New York. His father was a farmer who devoted far more attention to the elder poets than to the Rural New-Yorker. His mother is characterized by strength of will, depth of feeling, and pithiness of speech. Goethe tells us that he owed to his father his stature and his seriousness, and to his mother his happy disposition and his delight in story-telling. In Jordan's case this order was reversed. From the mother he seems to have inherited his executive power, and from the father his literary instinct. He grew up a very unusual farm product—a shy, observant lad, much given to lonely excursions with a copy of Gray's Botany in one pocket and Longfellow's poems in the other. He early exhibited his instinct for classification by attempting a *catalogue raisonné* of the Assyrian kings, but as his teacher could supply him with data for but two categories, viz., the *good* and the *bad*, his labors were not very fruitful. Owing to his distaste for the severe manual labor generally expected of boys on a farm, young Jordan was considered lazy by the neighbors, and doubtless some of them blamed his parents for allowing him to loiter and dream his time away.

Not that he was idle. He attended first the village school, and afterward, no secondary school for boys being accessible, was admitted to the academy for young ladies in the neighboring town of Warsaw. He learned French and Latin; he made a catalogue of the plants of his native county; he read a good deal of history, and grew intimate with the best American and English poets. But he was the victim of no rigorous system of academic routine. He came to his studies, as a boy comes to a well-spread table, with a healthy appetite. A stranger to "cram," his mind assimilated its own, rejected what was not food, and was never

converted from a natural organ into a machine for gerund grinding.

At a time when most of our teaching is little better than organized interference, the attitude of Jordan's parents is instructive. It is told of Darwin that, when one of his friends expressed surprise at the way he allowed his boys to run at loose ends, his reply was: "I dare not interfere; Nature can manage them better than I can." This recalls Wordsworth's abiding faith

> "that there are powers
> Which of themselves our minds impress;
> That we can feed this mind of ours
> In a wise passiveness."

It would be wrong to assume that this attitude toward education is purely negative. In a very positive sense it may be said of young Jordan, as of the good Lord Clifford, that

> "His daily teachers had been woods and rills."

Such an education might, or might not, be a good one for a bookkeeper, a forge master, or a minister; for a naturalist it was ideal. One of its outward results was that when, in 1869, the youth of eighteen entered the first freshman class at the Cornell University, he was found to be a learned authority on such diverse subjects as hoof-rot in sheep and the flora of Genesee and Wyoming Counties. His career as a teacher had already begun at the Warsaw Academy. In his junior year at Cornell he was appointed an instructor in botany. In his senior year he became President of the Natural History Society, which then counted among its members several men of unusual activity and ability, whose names are now not unknown in the scientific world. At least two of these gentlemen have made their grateful recognition of his high example and bracing personality a matter of record.

In 1872 he was graduated with the degree of M. S., being the only man who ever received the Master's degree from Cornell upon completion of an undergraduate course. Perhaps it is worth remarking that he shares with Mr. Andrew D. White alone the distinction of an honorary degree from the same university. Immediately after graduation he was appointed to the professorship of Natural History at Lombard University, Galesburg, Illinois. Here he began that systematic study of the fishes of the Mississippi Valley and the Great Lakes which he continued with so much success during the many years of his residence in Illinois, Wisconsin, and Indiana. Throughout these years all his summer vacations were spent in scientific excursions fruitful of result. Passing over some minor positions which he held but for a short

time, it is important to note that he was enrolled as a student at Penikese under Louis Agassiz, who was not slow to observe the remarkable powers of the young naturalist. In 1874 Jordan returned to Penikese as lecturer in marine botany. In the following year he became Professor of Biology at Butler University, near Indianapolis; in 1879, Professor of Zoölogy at the Indiana University; and in 1885, president of the same institution. This last position he held until 1891, when he was selected as the first President of the Leland Stanford Junior University.

In 1880 Jordan was appointed "Special Agent of the United States Census Bureau" for the investigation of the marine industries of the Pacific coast. In this capacity, with the assistance of Prof. Charles K. Gilbert, Jordan made the first comprehensive survey ever undertaken of the fishes, both fresh-water and marine, of our Occidental seaboard. The records of the scientific discoveries made in the course of this survey are scattered through many bulletins of the United States Fish Commission, while the chief economic results are recorded in the section of the Tenth Census Report devoted to fisheries.

Of Jordan's hundreds of published works, great and small, but a few of the most important can be enumerated here. The most bulky of them, A Synopsis of the Fishes of North America, is a book of nearly twelve hundred pages, the authorship of which is shared with Prof. Gilbert. The Manual of the Vertebrate Animals of the Northern United States (A. C. McClurg & Co.) has grown through several successive editions from a small pocket volume to a stout octavo of nearly four hundred pages. It is an extremely useful work, and attempts to give such guidance with respect to the classification of vertebrate animals as a botanical key gives with respect to our flora. In his Science Sketches (A. C. McClurg & Co., 1887) are collected several papers and addresses of a popular character. Noteworthy among them are The Story of a Salmon (first published in this magazine), The Story of a Stone (first published in St. Nicholas), Darwin, and The Ascent of the Matterhorn. Some of these sketches are marked by a union of sound knowledge, with a whimsical humor and delicate fancy which is sufficiently rare among men, whether scientific or literary, and which goes far to convince readers that Jordan might have attained a place in literature perhaps as distinguished as his place in science.

What always strikes even a casual observer in Jordan is that he seldom does things as other men do them. If it can not always be said that his way is the best, his unfailing success attests that it is anyhow the best for him. In bearing, phrase, turn of wit, and simplicity of life, he is unique, and that without the slightest affectation of originality. This was true of him as a student. He

was probably the best man of his time at college, yet he was rarely seen to study. He paid his expenses in one way and another by his own labor, yet he was a man of leisure. Despite his carelessness with respect to his personal appearance, and despite his whimsical address, his spiritual qualities marked him out as a man of fine breeding.

As a teacher, Jordan makes the impression of weight, sincerity, and simplicity. He rests down confidently upon the subject and makes that speak. He has the instinct attributed by Matthew Arnold to Wordsworth: he lets Nature speak through him "with her own bare, sheer, penetrating power." Students say he is the simplest of lecturers. Others may seem more profound because less lucid. Perhaps Jordan does not see everything—he does not wish to see everything—it is enough for him to see what is vital. Those who have time may dwell, if they will, in the skirts and suburbs of things; Jordan strikes for the center. He has the sense of an Indian for direction, and may be relied upon to bring his followers out of the woods as promptly as any guide who could be mentioned.

As an administrator, Jordan is a man of distinguished performance and splendid promise. In the course of six years he raised the State University of Indiana from a condition of obscurity and ineffectiveness to its present position in the front rank of Western colleges. This he did in the face of very great obstacles, of which, perhaps, the remoteness of the seat of the university and the parsimony of the State were the most formidable. His success was largely due to his policy of surrounding himself with a Faculty of young, energetic, progressive men, and of keeping the university in touch with society at large. As President of Stanford University he has to confront still greater difficulties, but he has the enormous advantages of far greater resources and of a vastly widened field of action.

Jordan is singularly fitted for the multiform duties and perplexities of his present position. Physically and mentally he is a massive man, as imperturbable as a mountain. He eats heartily, sleeps soundly, and turns off his work promptly, almost imperceptibly. Labors which break down ordinary men he takes as easily as a game of baseball, in which he delights; grinding disappointments seem to affect him little more than does the defeat of the Faculty team by the Freshmen. He is incapable of being interrupted; he will answer your questions and dispatch your business while finishing the identification and description of a new species of fish. He is impervious to the bore, not because he is thick-skinned, but because he does not stop long enough to let the bore insert his sting. His mind seems to be organized on the co-operative principle, so that he can carry on several lines of work simul-

taneously. It is, however, absurd to use the word "work" of the productive energy of a man who does everything with the unconscious ease of a child at play. The only thing that really worries him is a full-dress dinner, with its dissipating accompaniments of smoking, drinking, and speech-making. He is so thoroughly imbued with the conviction that a straight line is the shortest distance between two points that he is incapable of the circuitous treatment of a subject essential to the after-dinner speech. Like all penetrating minds, he is intolerant of verbiage, and has never been known to be guilty of a lapse into "fine writing."

Jordan is still in his prime, his vigor of mind and body unimpaired, and it is reasonable to hope that his main life work is still before him. But even should his career be cut short at any time, its influence would survive. The nature of this influence may be partially inferred from his published utterances on educational subjects; but only those who have been associated with him, either as fellow-teachers or as students, can be aware of its pervasive power. To scores of teachers and to hundreds of earnest students, Jordan has been something like a spiritual emancipator. It was delightful to see him, at the University of Weissnichtwo, confronting hide-bound pedants with the simple nature of things. He went quietly about his business; he did not strive nor cry, much less scold; but somehow tradition, system, dialectic, curriculum—everything in short that had hitherto passed unquestioned in that place—softly faded like the ghost when it begins to scent the morning air. Cautiously, after much debate, some changes were made; the timid hied to cover; but the sky did not fall. Once it became understood that change was possible in matters academic without greater harm than that of converting impotent philippics into whining jeremiads, things moved very rapidly. The great discovery was made that the laws of Nature operate in college as well as elsewhere. It was suggested that the way to educate a man is to set him at work; that the way to get him to work is to interest him; that the way to interest him is to vitalize his task by relating it to some sort of reality. Teachers were amazed to find that students work better when they are led than when they are driven. The abounding ingenuity of American youth, which had hitherto been exhausted in cheating at examinations, victimizing professors and freshmen, evading duty, eluding detection, and framing perennial excuses, found ample scope in fascinating experiments leading up to some scientific result. Without losing their natural vivacity boys became men, bringing to the serious work proper to men the spring and hopefulness of youth. College pranks ceased, but by no means college sports. Academic rules and regulations became dead-letter, not because of their frequent infringement, but because no need

longer remained for their enforcement. It came to be seen that a university community where every man is absorbed in his work may be made practically self-governing. Such a body of students has channels for the excretion of the idle and the vicious.

As may be surmised, the effect upon the instructor of such a series of reforms as those here glanced at was profound. The college scout was converted into the university professor. In case he proved recalcitrant to this high calling, he was permitted to "seek some other field of usefulness." In case he turned out worthy, his life acquired the value and dignity of high purpose, even when the practical work of organizing an educational experiment gave him little time for scientific or literary production. Upon the indebtedness of such men at several seats of learning to President Jordan, this is not the time to dilate. Suffice it to say that at Stanford University, where of course his influence is at its height, he has drawn a large number of diverse and energetic personalities into abiding harmony touching matters that pertain to educational salvation. Jordan's favorite quotation is the saying of Ulrich von Hutten, *"Die Luft der Freiheit weht"* ("Freedom is in the air"). This free air is to us the breath of life.

The common opinion, says Mr. Horatio Hale, in one of his anthropological papers, that women among savage tribes in general are treated with harshness, and are regarded as slaves, or at least as inferiors and drudges, is based on error, originating in too large and indiscriminate induction from narrow premises. A wider experience shows that this depressed condition of women really exists, but only in certain regions and under special circumstances. It is entirely a question of physical comfort, and mainly of abundance or lack of food. Where, owing to an inclement climate, as in arctic or subarctic America, or to a barren soil, as in Australia, food is scanty, and the people are frequently on the verge of famine, harsh conditions of social life prevail. When men in their full strength suffer from lack of the necessaries of existence, and are themselves slaves to the rigors of the elements, their better feelings are numbed or perverted, like those of shipwrecked people famishing on a raft. Under such circumstances the weaker members of the community—women, children, the old, the sick—are naturally the chief sufferers. The stories of the subjection of women, and of inhumanity to the feeble and aged, all come from these inhospitable regions. Where plenty prevails, as in tropical or subtropical America, and in most of the Polynesian islands, the natural sentiments resume their sway, and women enjoy a social position not inferior, and sometimes actually superior, to that which they possess in some civilized countries. The wife of a Samoan landowner or a Navajo shepherd has no occasion, so far as her position in her family or among her people is concerned, to envy the wife of a German peasant. The change which took place in the social condition of the Tinneh women, when their emigration had carried them from the bleak skies and frozen swamps of Athabaska to the sunny uplands and fruitful valleys of Arizona, is thus explained.

EDITOR'S TABLE.

THE LATE PROF. TYNDALL.

By the death of Prof. Tyndall England has lost not only one of her foremost men of science, but a man who, by his labors and his character, has contributed in an eminent degree to render the science of the nineteenth century honorable. Some men take to science as to a gainful trade, hoping that, in the competition of life, it will serve their turn better, perhaps, than any other career they see open to them. Others are led to it by a more or less amateurish curiosity. Others again enter upon the study of it from a sense of the importance of the truths and principles it unfolds and from a desire to place such knowledge as they may gain at the service of mankind. In the latter class we must place the late Prof. Tyndall. No man ever felt more fully and deeply than he that the investigation of the laws of Nature was a ministry, the essential preparation for which lay in a candid mind and a readiness to impart as freely as one received; and no scientific man of our time, it may confidently be said, has maintained a more unbroken record of personal high-mindedness, of broad humanity, and ungrudging helpfulness.

In the various notices of him that have appeared in the press since his death, the leading incidents of the late professor's life have been sufficiently stated, and we need not on the present occasion go into many biographical details. From his father he inherited neither social position nor wealth; but what he did inherit was of far more importance than either or both—a sound constitution, a well-developed brain, and a character in which courage, independence, and love of truth were the predominant elements. The philosopher Schopenhauer prefixed to the second edition of his principal work an elaborate dedication to the *manes* of his father, whom he eulogized chiefly for having left him an ample provision of worldly means, whereby he had been enabled to devote himself to intellectual labor without any anxiety for his subsistence. "Thy presiding care," he says, "hath sheltered and borne me, not merely through helpless childhood and unregarding youth, but even in manhood and up to the present day. For as thou didst bring into the world a son such as I am, thou didst also make provision that, in a world like this, such a son should be able to subsist and develop himself." We quote this as evincing a spirit the very opposite of Tyndall's. He did not trouble himself about what kind of a world he was born into, but from the first resolved to take things as he found them and make his way in the world by dint of honesty, industry, and courage. Leaving school in his nineteenth year, he took service on the Ordnance Survey of Ireland, and in turn performed every branch of the work from the most mechanical to the most theoretical, and thus made considerable progress in what were already favorite studies of his—geometry and trigonometry. This was not sufficient, however, for his active mind and strenuous disposition. A few words of counsel given to him by an official of the survey as to the best use to which to put his spare time caused him to enter on a systematic course of study. At five o'clock next morning he was at his books, and, having adopted this plan, he kept it up without interruption for twelve years. The salaries paid on the Ordnance Survey, at least to the juniors, were not large, and when Tyndall retired from it in 1843, after four or five years' service, his wages were only

twenty shillings a week. "I have often wondered since," he observed in an address * delivered in the year 1884, "at the amount of genuine happiness which a young fellow of regular habits, not caring for either pipe or mug, may extract even from pay like that." He next found employment in railroad surveying, the railway-building mania in England being then at its height. The remuneration was a little better than in his former position, but the work was terrible. "The day's work in the field," he tells us, "usually began and ended with the day's light, while frequently in the office. and more especially as the awful 30th of November—the latest date at which plans and sections of projected lines could be deposited at the Board of Trade—drew near, there was little difference between day and night, every hour of the twenty-four being absorbed in the work of preparation. Strong men were broken down by the strain and labor of that arduous time. . . . In my own modest sphere I well remember the refreshment I occasionally derived from five minutes' sleep on a deal table with Babbage and Callet's Logarithms under my head for a pillow." A better school for expelling any sickly dreams or pessimisms that might haunt a young man's brain could not easily be imagined. Possibly more than one rather discouraging philosophical treatise might never have been written had the authors been required to go through a similar experience. At one moment the idea of speculating in railway shares took possession of the young surveyor's mind. He made a purchase in the most legitimate way, and for three weeks was the most miserable of men; when, finding the burden intolerable, he went back to his brokers and "unloaded" at the exact price he had paid.

After four years of railway work Tyndall accepted a position as teacher of mathematics at Queenwood College in Hampshire. Here he learned by practical experience that two factors went to the formation of a teacher, ability to inform and ability to stimulate. To quote his own words in the address already referred to: "A power of character must underlie and enforce the work of the intellect. There are men who can so rouse and energize their pupils as to make the hardest work agreeable. Without this power it is questionable whether the teacher can ever really enjoy his vocation—with it I do not know a higher, nobler, more blessed calling than that of the man who, scorning the cramming so prevalent in our day, converts the knowledge he imparts into a lever to lift, exercise, and strengthen the growing minds committed to his care." After a year of teaching the ardent student gathered all he had saved up to that time, some two hundred pounds, and went over to Germany in order to take a course in science at the University of Marburg, which at the time was enjoying great repute through the lectures of the illustrious chemist Bunsen. It was neither a desire for money nor a desire for fame, he tells us, that took him to Germany. He had been reading Fichte and Emerson and Carlyle, and had been touched by their spirit. "The Alpha and Omega of their teaching was loyalty to duty. Higher knowledge and greater strength were within reach of the man who unflinchingly enacted his best insight." Living was cheap at Marburg in those days: a good dinner could be got for eightpence—a more bounteous dinner, indeed, than so abstemious a liver as Tyndall cared to eat; for it consisted of several courses, while he generally limited himself to one, not caring to waste any of his energy in needless wear and tear of his digestive organs. After studying for a time at Marburg he went to Berlin, where he fell in with a

* My Schools and Schoolmasters. Reprinted in The Popular Science Monthly for January, 1885.

number of very eminent men of science, with all of whom he formed the most satisfactory relations. "The philosophers of Germany," he says—and the testimony is one of which Germans may be proud—"were men of the loftiest moral tone." It was the recognition which Tyndall's scientific essays received in Germany which awakened the world of science in England to a sense of his greatness. In 1852 he was elected a Fellow of the Royal Society, and in June of the year following he was appointed Professor of Natural Philosophy in the Royal Institution, of which, on the retirement of Faraday a few years later, he became superintendent.

It is needless to give an enumeration of the works which Prof. Tyndall gave to the world, but we may remark that his life-work falls into two portions, original research into the most abstruse questions of science and earnest attempts at the popularization of scientific knowledge. There are those who are pleased to say that scientific knowledge can not be popularized; but the statement would be safer if it affirmed merely their own inability to popularize it—an inability which, in some cases, we have very little doubt, springs from unwillingness. No man ever knew better or felt more strongly than Prof. Tyndall how rigorous are the demands of scientific investigation in the way both of preparation and of method, and yet no man was more willing than he, whenever his severer engagements permitted, to open, or try to open, the door of knowledge to the unlearned public. "Look jealously," he said twenty years ago, on the occasion of the banquet to him in this city, "upon the investigator who is fond of wandering from his true vocation to appear on public platforms. The practice is absolutely destructive of original work of a high order." True enough, the man who, being supposedly equipped for the work of advanced investigation, is *fond* of wandering from that work in order to appear on public platforms, is a man our confidence in whom as an original investigator is apt to be weakened; but it is one thing to be fond of escaping from the severer tasks of science and quite another to relinquish them from time to time under a sense of duty; and we should be inclined to say that no man should be so immersed in the specialties and technicalities of minute investigation as to be unable to lay before a popular audience a general view of some portion ot the scientific field. How the possession of the power to do the latter would interfere with the power of carrying on even the profoundest studies we are at a loss to imagine, though we are prepared to admit that possibly the constant habit of dealing with difficult and abstruse problems, the very language and symbolism of which are absolutely unintelligible to the lay mind, may, if allowed to do so, develop a real incapacity for popular exposition. It did not, however, lead to this result in the case of Prof. Tyndall, nor in that of his even greater predecessor Faraday; and we venture to conjecture that the great Sir Isaac Newton himself could, if he had wished, have delivered a very good popular lecture in astronomy.

We have spoken of Prof. Tyndall's visit to this country. No man of science from abroad was ever more heartily received; perhaps none was ever so heartily received, and yet we have had among us Huxley and Spencer, who both stand very high in the opinion and regard of the American people. How disinterestedly he pursued his vocation here is doubtless known to all our readers. Had his object been to make money he could have returned to England with the respectable sum — for a scientific man—of thirteen thousand dollars in his pocket. That was not his object, however; and, finding himself possessed of this sum over and above all the expenses of his tour, he placed it in the hands of trustees for the assistance of

students without means who might wish to devote themselves to scientific research. Difficulties having presented themselves in the way of applying the money precisely as intended, the trustees retained it with Prof. Tyndall's approval, and finally divided it between the Universities of Harvard, Columbia, and Pennsylvania, each receiving—so successful had been the management of the fund—no less a sum than ten thousand eight hundred dollars. The generous donor of the original sum had a good right to say as he did at the banquet, "Not as a servant of Mammon do I ask you to take science to your hearts, but as the strengthener and enlightener of the mind of man." These words were the key to his own life, and might well be engraved on any monument raised in his honor.

Dr. Andrew D. White contributes to this number of the Monthly the first of a group of papers which, while they form part of his New Chapters in the Warfare of Science, have also a distinctive leading idea. Their general title is From Creation to Evolution, and they are intended to show that the modern scientific conception of the universe, including man and his activities, has been developed out of the theological and metaphysical conceptions through a continuous progression. In the article published this month the change of belief in regard to the formation of the earth and stars is traced, and, as our readers will find, with all the wealth and definiteness of evidence which always characterize Dr. White's writings.

LITERARY NOTICES.

Romance of a Born Criminal. Milan: Chiesi, 1893.

This remarkable book, published and prefaced by a well-known Italian criminal anthropologist, can not and ought not to be judged by the usual canons of criticism. The title of romance must be subjectively justified, since the feeling that inspired the protagonist, a convict, to write these pages was certainly not diverse from that which moves other contemporary authors to expose their intimate ideas and sentiments in biographical form. Le Crime et le Châtiment, by Dostojewski; La Bête Humaine, by Émile Zola, Giovanni Episcopo, and L'Innocent, by Gabriele d' Annunzio, are the latest examples of this pathological literature, in which the skill of the authors opens before our minds a vista of deep knowledge of morbid states of mind, in which art takes the place of truth. In this book art there is none, but of truth there is perhaps a great deal more, and the very literary inexperience of the writer throws this into high relief; for, if truth comes to the fore because it is touched with the accent of veracity, what is false can not be glossed over here as with professional scribes, who know how to varnish and pleasantly hide by means of a pleasing and misleading style. It may have been the writer's intention to indite a work of art, but he has succeeded rather in furnishing the world with a most precious scientific and human document, and as a scientific document the book must be perused. The adventures of this *capo camorra*, a perfect type of the instinctive criminal, who believes he can justify and rehabilitate himself in the eyes of the world by recounting his crimes, his changes of fortune, are not without interest. The protagonist endeavors to attenuate and almost to vindicate the former by excusing them in his own way. In publishing this work A. G. Bianchi wishes to give a practical illustration of the theories of the new penal school of criminal anthropology which, thanks to Lombroso, Tamassia, and other well-known observers, has developed so greatly in Italy, and is beginning to influence the decrees of human justice when called upon to decide on the culpability of criminals. This book by Bianchi is, in short, the offspring of analytical studies.

"This work of mine," says Bianchi in his preface, "ought to be a help to the study of individual criminality, whether subjectively by the narration of his own adventures by the delinquent himself, or objectively and scientifically, thanks to the help of the great *savant*, Silvio Venturi, professor at the university at Naples and director of the lunatic

asylum at Girifalco, who was able to know, observe, and study the subject of this book."

Bianchi defines Antonino M. as a graphomaniac. His memoirs are important documents in many ways. For example, they help us to estimate how far those modern and ancient writers were sincere who have given to us real or fancied confessions. In some respects, *mutatis mutandis*, these pages recall to our minds Rousseau's famous Confessions. Here, as there, we encounter an absolute lack of the sense of shame which seems a distinctive feature of the instinctive criminal. And who, judging Rousseau by modern standards, would deny that he had in him many traits of the born criminal? This work should make jurists and sociologists pause to think Surely prison life should turn out its inmates not only punished but corrected. Yet from these pages we learn that they are apt to issue forth more expert thieves than they entered. This book is really to the thoughtful an indirect apologia for capital punishment.

Signor Bianchi's book is a new proof of how incessantly the positive school of criminal anthropology labors in Italy, and what many and diverse modes they adopt to make known and to popularize their science.

The Bible: its Origin, Growth, and Character. By J. T. Sunderland, D. D. Putnams.

This book makes no claim to originality, but is an excellent summary of the most probable conclusions of modern scholarship on the questions discussed. It covers the ground admirably for so small a work. It is reverent in spirit and judicious in statement, and all who desire to know just what the best thought on biblical criticism is should read this book. Its chapters on the canon, the text, and the infallibility of the Scriptures are specially fine and interesting, and it is astonishing that any one, with such facts before him as are here stated, can believe in the inerrancy of the Bible, and it is still more astounding that those who dispute this dogma should be expelled from the Church. The vexed question of the Pentateuch, or rather the Hexateuch, the origin and authorship of the Old Testament histories, the Psalms, the Prophecies, etc., the composition of the Gospels and Epistles of the New Testament are all ably discussed. The author holds that "sacred books or Bibles come into being naturally. They are a necessary and inevitable outgrowth of the religious nature of man." Again he says: "Our Bible, particularly our New Testament, is greatly superior to any of the Bibles of the so-called heathen peoples. But the difference is one of degree, not of kind." He denies the mechanical theory of inspiration, which makes the Bible writers mere penmen of the Deity, but admits that they were "quickened by touch with the Infinite Mind and illuminated by that Light which lighteth every man that cometh into the world." These quotations are sufficient to give a general idea of the nature of the book. An excellent bibliographical appendix is added.

The Story of my Life from Childhood to Manhood. By Georg Ebers. New York: D. Appleton & Co. Pp. 382. Price, $1.25.

In this volume Dr. Ebers tells of his family relations in childhood, of his school days, of the beginning of his career, and of the friendships he formed, with only a single sensational element in the political disturbances of 1848; and we follow the whole with deep interest. As he was born in a country quarter of Berlin where now the city is dense around, before there were railroads, when the journey to his grandfather's in Holland required several days, and when tinder boxes had not been superseded by matches, his story helps us realize the extent of the social changes that have taken place. Remarkable changes have likewise been wrought during his lifetime in the political affairs of Germany; and nothing gives him more cause for gratitude "than the boon of being permitted to see the realization and fulfillment of the dream of so many former nations and my dismembered native land united into one grand, beautiful whole. I deem it a great happiness to have been a contemporary of Emperor William I, Bismarck, and von Moltke, witnessed their great deeds as a man of mature years, and shared the enthusiasm which enabled these men to make our German Fatherland the powerful united land it is to-day." A picture is given of the revolutionary excitement of 1848 in Berlin. Dr. Ebers passed through the Keil-

hau Institute, where Froebel's spirit prevailed, the gymnasium at Koltbus, and the University of Göttingen, and after a serious illness began to prepare himself for his life work. He relinquished the study of the law, which he had begun, and was attracted to Egyptology. He had no guide, but found an adviser in Jacob Grimm. Grimm told him he was beginning at the wrong end. His decipherment of hieroglyphics could only make him a dragoman, while he must become a scholar in the higher sense, a real and thorough one. "The first step is to lay the linguistic foundation." He obeyed this counsel, studied, with Lepsius and Brugsch to oversee and advise him; and after he had studied, wrote his sketches and novels. In teaching this example of thorough preparation the book, besides the pleasure it gives, furnishes a valuable lesson.

Build Well: The Basis of Individual, Home, and National Elevation; The Plain Truths relating to the Obligations of Marriage and Parentage. By C. A. Greene, M. D. Boston: D. Lothrop & Co. Pp. 233.

The rough self-regulation by which society protects itself against evil influences is seen in its treatment of books of this class. Written so often by charlatans from purely mercenary motives, and hence appealing to a widely prevalent craving for loose literature, it has happened that all books upon this theme done in a popular style are considered disreputable if not positively pernicious. This feeling keeps down their circulation and prevents a great deal of mischief that would arise from the perusal. But in creating a feeling that prevents the proper study of these subjects in the family other grave evils are begotten for which the only remedy is a more discriminating public opinion. Certainly there is no other form of knowledge that so vitally interests the individual or the nation as this relating to the obligations of marriage and parentage.

It concerns the one function to which all others are subservient, which governs our actions in a greater degree than any other, which has the greatest power for happiness or misery over our lives, and which, above all, owing to the more or less unnatural position in which modern civilization places us, is not satisfactorily governed by our instincts and desires. It seems very irrational that this central function about which all others are grouped should be a tabooed subject, not to be read about or even thought about till the individual has suffered oftentimes irreparably through his ignorance.

This work, Build Well, has evidently been written with an earnest and devout desire to help the public in this greatly needed direction. And nobody can understand more truly the perishing need there is of such help than its author, who for more than thirty years has been in charge of a successful sanitarium for the treatment of the diseases of women. If profound learning, wide experience, marvelous powers of intuition, and the tenderest sympathy with suffering are a proper warrant for treating this subject, Dr. Greene can certainly claim her right to a hearing. It is a work that ought to be read and pondered over by every father and mother, and it will be the greatest help to any young person of either sex about to join fortunes with another for life. It is a book that will do much toward correcting many false impressions regarding not only purely physiological questions, but also some social fallacies, more especially having to do with the marriage relation. In the first chapter, entitled Introductory Thoughts and Inquiries, the author asks the question, "Are all the unfortunate results of heredity a necessity?" and answers it strongly in the negative. Chapter II, headed Man, deals with the outward results on face and form of certain ways of living and habits of thought. Chapter III is given over to an embryological excursion, and sums up with the conclusion that "dual force is indispensable in our world to the full conservation of all living things." Chapter IV gives in detail the more important physiological facts relating to and governing the phenomenon of reproduction. In Chapter V the author treats of the same subjects, but more in their dual and emotional aspects. Chapter VI deals with the proper care of the mother during intrauterine life. Chapter VII is devoted to a discussion of the Proper Conduct of the Marital Relations. The remainder of the book—with the exception of two chapters, The Love of Manhood and The Love of Womanhood—consists of a consideration of some of the various diseases, both mental and

physical, which may affect the reproductive function. The book is an extremely satisfactory one and calculated to do much good.

Text-Book of Geology. By Sir Archibald Geikie, F. R. S. Third edition, revised and enlarged. London and New York: Macmillan & Co. Pp. 1147. Price, $7.50.

It is little enough to say of this text-book, by the most eminent of living geologists, that it is a most able and authoritative work. Its scope and characteristics were set forth in the notice of its first edition, in the twenty-second volume of this magazine. The present edition has been entirely revised, and in some portions recast or rewritten, so as to bring it abreast of the continuous advance of geological science. The additions made to the text, which extend to every branch of the subject, increase the volume by about one hundred and fifty pages. The position of the author as Director-General of the Geological Survey of Great Britain and Ireland has given him exceptional facilities for securing the utmost fullness and accuracy attainable in a geological treatise, and it is greatly to the credit of the British Government that it keeps such a man in such a place.

Essays on Rural Hygiene. By George Vivian Poore, M. D., F. R. C. P. London: Longmans, Green, & Co., 1893. Crown 8vo, pp. 330. Price, $2.

The author states that eight of the thirteen chapters of this work have been previously published as lectures, addresses, or essays, but notwithstanding the desultory manner of their appearance there is a continuity in the subject matter, and the book has none of the characteristics of a collection of published papers.

He tells us that the title Rural Hygiene was chosen because it is only in places having a rural or semi-rural character that it is possible to be guided by scientific principles in our measures for the preservation of health and the prevention of disease. He considers that the hygienic arrangements in cities are the products of expediency rather than principle, and are not infrequently carried out in defiance of the teachings of pure science. He truly says that if the rural element be entirely banished from our towns, and if the fearful concentration of population that is seen in the modern city, both in England and America, be allowed to proceed unchecked, we are in a fair way to increase rather than decrease the liability of our towns to suffer from epidemics. He expresses the Utopian sentiment that before the nineteenth century closes people will begin to see the advantages not only of rural features in the city but also of urban features in the country.

In the first and second chapters, on the concentration of population in cities, it is insisted that this is an indirect effect of our modern sanitary methods, that give a fatal facility for the packing of houses in dangerous proximity to each other. It is shown that the retention of a rural element in rapidly developing towns, by allowing open spaces to exist between houses, has great advantages on the score of health as well as on that of finance.

Some of the shortcomings of modern sanitary methods are dealt with in the third chapter; such as the mixing of putrescible matter with water, that leads to the dissemination of water-borne diseases, to the pollution of rivers, and the poisoning of wells.

The fourth chapter, on the "living earth," shows that by virtue of the animal and vegetable organisms contained in humus it has the marvelous power not only of turning organic matter into food for plants, but of protecting the air and water from animal pollutions.

The many evils associated with what are known as modern sanitary fittings are reviewed in the fifth chapter, on the house. It is insisted upon that no house can be securely and permanently wholesome unless it have tolerably direct relations with cultivable land.

The sixth chapter discusses some of the elementary facts in regard to air as well as the relationship that exists between the earth and the air. The latter is freshened by vegetation, and when the air in cities becomes too foul to allow vegetation to flourish a danger to health is in existence.

The seventh chapter shows that, if we want pure water, a scientific and careful disposal of putrescible refuse is necessary; and the relations that exist between earth and water are discussed.

In the eighth, ninth, tenth, and eleventh

chapters the practical details of the various problems of domestic sanitation are discussed from the standpoint of personal experience.

The author advocates, in the twelfth chapter, the advantages of inhumation over cremation, because the former is cheaper, simpler, and quicker, and it is productive, not destructive.

The thirteenth chapter gives a brief biography of Nicolas Thomas Bremontier, and describes his successful efforts in the reclamation of the sand wastes of Gascony.

There is a great deal of sound common sense in this volume, and the advice it gives can not but be of advantage to every householder.

The Meaning and the Method of Life. A Search for Religion in Biology. By George M. Gould, A. M., M. D. New York: G. P. Putnam's Sons, 1893. Pp. 297. Price, $1.75.

It would seem that the anagram that some schoolman of the middle ages made of Pontius Pilate's question, *Quid est veritas?* (What is truth?) the letters being ingeniously transposed into *Est vir qui adest* (It is the man who is before you), anticipated the fundamental fact of Dr. Gould's philosophy. For as in the life of Him that was tried by Pilate is to be found an explanation of life's meaning and a suggestion of its method, so in all living matter does Dr. Gould find an evidence of the Deity. He says, "It is plain that a practically omnipresent, invisible, living, intelligent force is operating in and through every living thing." He does not consider that the inorganic world shows any hint of design or of divinity. In the word *Biologos* he would connate the purpose, wisdom, and intelligence instinct in every living thing, and his philosophy takes no heed of unknown power and possibility. This is a wide step beyond agnosticism, that the author considers an unmanly resignation and despair after a first defeat, and yet beyond monism that he says is muddleism, or pantheism that ignores the dead material, or materialism that ignores the living worker. Rather than an infinite there is a finite creative being, aiming at the highest, encouraging all that is good, and while combating the bad still often baffled because of the refractoriness of material laws.

The world may be considered as a letter direct from the Father's own hand, advising us, telling us of himself, and urging us to hasten our return to him. During the long journey we read it over and over again, delighted at the kindness it witnesses, and the beautiful suggestions it gives of his thoughtfulness and wisdom and lovableness.

The author's creed is that the extension and perfection of healthy life over the globe are the plainest aim and the most primary work of Biologos. Whatever aids in that is right and whatever opposes it is wrong.

Many will not, can not accept Dr. Gould's conclusions, but all must be impressed by his earnestness that finds expression in such sentiments: "Dazzled and dazed the scientific mind is at present like the aphakic, suddenly brought to see, but not recognizing or knowing what he sees. It still sees men as trees walking, and does not know that what it sees is at last the benignant and beckoning God himself."

A Dictionary of Birds. By Alfred Newton, assisted by Hans Gadow. With Contributions from Richard Lydekker, Charles S. Roy, and Robert W. Shufeldt, M. D. Part I (A to Ga) and II (Ga to Moa). London: Adam and Charles Black; New York: Macmillan & Co. Pp. 304. Price, $2.60 each.

This work is founded on a series of articles contributed to the ninth edition of the Encyclopædia Britannica, modified so as to make them more continuous so far as alphabetical arrangement will admit, and supplemented by the intercalation of a much greater number. Of the additional articles the most important, chiefly anatomical, are furnished by Dr. Gadow. Dr. Shufeldt, of Washington, who is well known to our readers by his contributions to the Monthly, has also furnished valuable aid. In the choice of subjects for additional articles the author has aimed to supply information which he knows, from inquiries made of him, is greatly needed. Hence he has had regard to names found in books of travel and other works, which no dictionary will explain. But there are other names, compounded (mostly of late years) by writers on ornithology, which have not come, and are not likely to come, into general use; and these are left out, for "these clumsy inventions

are seldom found but in technical works, where their meaning, if they have one that is definite, is at once made evident." Hence many local names, except those which have found their way "into some sort of literature," are omitted. Yet, though arbitrary, the author has tried to make his method tend to utility. The longer articles consist chiefly of descriptions of birds, with notices of synonyms, and excellent papers on bird anatomy. A map of the world on Mercator's projection shows the bird regions and their boundaries.

A Popular History of Astronomy in the Nineteenth Century. By Agnes M. Clark. Third edition. New York: Macmillan & Co. Pp. 573.

The revision called for by the great number and importance of the astronomical discoveries that have been made since the last previous edition of this book was published has been made with great care and pains, and with the aim, not only of furnishing the new information, but also of so completely incorporating it with the pre-existing text as to leave no gaps in the narrative suggesting interpolations. The book has thus grown and been brought down to date "by a process of assimilation rather than of mere accretion." The foot-note references have been multiplied; the index has been made more copious; the chronological table has been considerably extended; and several new tables of data have been appended.

The Ore Deposits of the United States. By James F. Kemp. New York: The Scientific Publishing Company. Pp. 302. Price, $4.

The claim is made for this book that it fills a vacancy in our scientific literature, for no complete review of the ore deposits in our country has appeared since the publication of Whitney's Metallic Wealth in the United States in 1854. Yet within the last forty years enormous developments have been made in new mining districts, the relative importance of different regions has changed, and great advances have been made in our theoretical knowledge regarding the origin and formation of ore beds. The present work has been conceived with such considerations as these in view. A twofold purpose is to supply a condensed account of the metalliferous resources of the country which shall be readable and serviceable as a text-book and book of reference; and to treat the subject in such a way as to stimulate investigation and study of the phenomena. The ore deposits are taken according to the metals they yield. The treatment is geological, and the principles of origin have been made prominent. To the descriptions of others the author adds observations made by himself in travel during the last ten years.

Camp Fires of a Naturalist. By Clarence C. Edwords. New York: D. Appleton & Co. Pp. 304. Price, $1.50.

Prof. Lewis Lindsay Dyche, of the University of Kansas, enjoyed in his boyhood and youth the life of a pioneer on the plains. He lived in close communion with Nature, among the animals and plants, and grew up a naturalist. He acquired a school and college education largely by means of his own efforts, was graduated from the university at the head of his class, and became an assistant and afterward professor of anatomy and physiology there, of zoölogy and animal histology, curator of the natural history museum, and director of the taxidermical work. In the museum stands, according to Mr. Edwords, the finest collection of mounted animals in the world—his creation. This book is devoted to the relation of the story of the incidents and adventures of his fourteen expeditions after North American mammals. It is taken from his note-books and diaries, with nothing added to the facts he has recorded. The adventures are not of a thrilling kind, but present the life of the woods as it actually is, in a dramatic form, with sketches of scenery and the life of the hunting camp, and information about the character and habits of the animals hunted.

Socialism and the American Spirit. By Nicholas Paine Gilman. Boston and New York: Houghton, Mifflin & Co. Pp. 376. Price, $1.50.

The development of socialism in the United States is thoroughly discussed in the thirteen chapters of this volume. Whether the American spirit conforms to Mr. Gilman's outlines is a doubtful matter. He may de-

pict a stage of its existence. There are other times when it does not fly, but crawls, or else is wrapped in a web of indifference. The preface contains the lesson of the book —the way to Utopia is for all of us over the difficult road of moral improvement.

According to strict definition, pure individualism separates man from his kind, calls government an evil, and tends toward anarchy, while socialism makes man dependent, exalts government, and ends in communism. Either alone is impracticable as a method of life. The wise man therefore uses both as he employs his two eyes or hands. In the domain of politics and property, the individualist seeks liberty, private capital, ownership, and competition; the socialist demands authority, common possessions, and collective capital. The thorough American is an opportunist, wary of extremes, caring little for theory, and adopting only what is successful in practice. The tendency of the time, however, is in all countries distinctively socialistic.

Mr. Gilman deprecates the pseudo-scientific method in treating politics, economics, and ethics. The right order of things has been strangely mistaken by scientists—more properly sciolists. The knowledge of man is of more importance than the most astonishing development of natural science. Pure individualism, he conceives, is best illustrated by the struggles of brute man in prehistoric ages. We have, or ought to have, outgrown this struggle-for-existence ethics. It is a blunder in thought to introduce the evolution philosophy in place of the higher law for man.

The social problem, largely due to unrestricted immigration, belongs to the city. The labor question does not trouble the farmer, and it must be remembered that three fourths of the population still dwell outside the large cities. A difference is noted between English and American individualism. Twenty-five years ago liberal Americans avowed Mr. Spencer's political creed. No longer do they belong to the *Suspenceru-maru-homi*—the sect that swallowed Spencer whole! Government is not a monstrosity, but the organ which expresses the intelligence and will of a reflecting community. Elsewhere the author states that to take anything out of politics in civilized countries means to take it out of corruption into honesty!

Among socialistic measures the American accepts free schools, free libraries, and free text-books as benefits, while he rejects the state publication of books as a failure.

Nationalism, or romantic socialism, flourishes chiefly on paper. It was doomed to failure since it ignored the separate commonwealths. Christian socialism aims to accomplish by religious influence what socialism attempts in the reconstruction of society.

Without violent reforms the industrial situation may be much improved by means of boards of arbitration, building associations, life insurance, and a better form of labor contract. There are now over three hundred business firms that practice some form of profit sharing. We may expect the functions of the state to be enlarged, but purification of existing method should precede this extension. As a way of escape from present evils, the author directs us to a higher individualism, properly Christian. This favors voluntary co-operation, and aims at fraternalism.

Mr. *Joseph John Murphy* is the author of a book entitled *The Scientific Bases of Faith*, published twenty years ago, the purpose of which was to show that the new ideas of the nature and origin of things, including the entire doctrine of evolution, constitute a better basis for Theistic and Christian faith than the old. Since the book was published much has been thought, said, and written on the subjects of which it treats; and a second book, *Natural Selection and Spiritual Freedom*, is now presented by the author to set forth his newer thoughts on the same class of subjects. In it Prof. Drummond's Natural Law in the Spiritual World receives prominent attention, and Mr. Murphy has to "remark with wonder over the vast change that must have come over the religious mind of the English-speaking people before Prof. Drummond's work could have been received as an orthodox book," which, we may say by the way, it is not, because "there is not one of Drummond's characteristic passages which might not have been written by a denier of the characteristic doctrines of apostolic and Nicene Christianity." Drummond's doctrine of conversion is first ex-

amined; then the Darwinian doctrine of progress by natural selection among spontaneous variations is shown to be a case of "natural law," which is true also of the "spiritual world." The question of the fate of those rejected in God's selective judgment and the subject of freedom are next considered; and the final chapter contains an argument against both gnosticism and agnosticism, and in favor of "religious common sense." (Macmillan & Co. Price, $1.75.)

Mrs. *Schuyler Van Rensselaer* believes that landscape gardening is a real art, and in *Art Out of Doors* asks that it be recognized as on a par with architecture, sculpture, and painting. "The mere statement of its purposes," she says, "should show that it is truly an art. The effort to produce organic beaty is what makes a man an artist"; and this is done by the man who uses ground and plants, roads and paths, and water and accessory buildings, with an eye to organic beauty of effect. Then, having shown what are or should be the aims and methods of landscape gardening, she goes on to describe its particular features and accessories—the home ground and "close to the house," roads and paths, piazzas, formal flower beds and formal gardening when they are in place, architecture, outdoor monuments, and trees. In the chapter entitled "A Word for the Axe" she advocates the removal of trees that interfere with the artistic plan, no matter how dear they may be to the individual owner. Other chapters deal with cemeteries, the love of Nature, books as an aid to the love of Nature, and the artist. (New York: Charles Scribner's Sons. Price, $1.50.)

The Niagara Book is designed to remedy what its projectors regard as a lack of a good souvenir of Niagara Falls. They have tried, "by securing the co-operation of the most prominent literary men in America, to supply such a need. By following an idea of their own they have persuaded representative men in their lines to write for the book original stories, sketches, and essays—descriptive, humorous, historical, and scientific—dealing directly with Niagara Falls." The articles are of unequal merit. They are: Niagara, First and Last, by W. D. Howells; What to See, by Frederick Almy; The Geology of Niagara Falls, by Prof. N. S. Shaler; The First Authentic Mention of Niagara Falls, by Mark Twain; Famous Visitors at Niagara Falls, by Thomas R. Slicer; Historic Niagara, by Peter A. Porter; The Flora and Fauna of Niagara Falls, by David F. Day; As it Rushes by, by Edward S. Martin; The Utilization of Niagara's Power, by Coleman Sellers; and The Hydraulic Canal. These are illustrated by photo-copies from water colors and drawings by Harry Fenn. (Underhill & Nichol, Buffalo. Price, $1.50.)

The Revolt of the Brutes (C. T. Dillingham, 50 cents) is unique among the books of the year. It describes a convention consisting of an "upper house" of air-breathers, which is supposed to meet on the shore of Lake Michigan, and a "lower house" of water-dwellers assembling in the lake itself. After a lively debate, in which the wrongs done by man to the brutes are set forth, the extermination of the human race is resolved upon, and means are chosen for putting this purpose in execution. The proceedings of the convention are humorously recounted and the officers of both "houses" are described in the same vein. Throughout the text is kept up a running fire of allusions and witticisms, and one must be widely read to appreciate them all. The author is Mr. *Hyland C. Kirk*, who has published Heavy Guns and Light, The Possibility of not Dying, etc. A word must be said for his illustrations, which are many and display great ingenuity in the posing of the creatures represented.

The merits of *William Swinton's School History of the United States* are too well known to need elaboration at this day. It was prepared to meet the views of teachers who are aiming at definite results in the stady. A revised and readjusted edition of the book is now offered by the American Book Company, in which are added an introductory chapter on Prehistoric America, and a chapter giving some account of the settlement of the three colonial centers—Boston, New York, and Philadelphia. Price, 90 cents.

The American Book Company publishes, as additional volumes in its series of English classics for schools, *Matthew Arnold's* poem, *Sohrab and Rustum*, and *Ralph Waldo Emerson's* essays on *The American Scholar*. To the former volume are prefixed an account of the life and the critical and educa-

tional work of Mr. Arnold and an outline of the story on which the poem is founded; and to the latter, a sketch of Mr. Emerson's life and an inquiry into his religious belief, which is deemed necessary for a proper understanding of his writings. (Price, 20 cents each).

Mr. *E. A. Kirkpatrick*, of the State Normal School, Winona, Minn., has prepared, primarily for use in his own classes, a manual of *Inductive Psychology*, or introduction to the study of mental phenomena, in which a kind of experimental method is applied. The pupil, instead of taking what the author tells him about imaginary mental processes, is expected to analyze and observe the actual processes of his own mind and those of others, whereby he may be led to observe, judge, and think for himself. (Published by the author.)

The *Exercises in Greek Prose Composition*, based on Xenophon's Anabasis, of *William R. Harper* and *Clarence F. Castle*, originated in the belief that Greek prose composition is not an end to be sought for its own sake, but a means for learning the principles of the Greek language, that they may become the key to unlock its literature. The method adopted is believed to be one that will stimulate observation and investigation, and so become an inductive process. The text book matter is preceded by some helpful suggestions about composition, and followed by a series of inductive studies in the uses of the Greek modes. (American Book Company. Price, 75 cents.)

The Principles of Fitting—engine fitting it is usually called, but the author objects to that designation as being too special—by a foreman pattern maker, is a manual designed for apprentices and students in technical schools. The author has directed his attention to those cardinal matters which lie at the basis of the trade, in preference to entering into a multitude of details that would be applicable only to the practice of a limited class of shops. He has also assumed that his readers are thrown upon their own resources without the aid of the automatic machines of modern shops, and has devoted considerable space to vise work. (Macmillan & Co. Price, $1.50.)

The main purpose of the *Duchess of Cleveland's* relation of *The True Story of Kaspar Hauser from Official Documents* appears to be the vindication of her father, the Earl of Stanhope, who had the care of the mysterious personage during the latter part of his career, against the aspersions which have been cast upon his motives and conduct by certain writers who have assumed to tell the story. The author's version is told in a terse and vigorous style, with pungent criticism and comment. She regards Kaspar Hauser as simply an impostor and liar, whose whole life and conduct were a deception, and who fabricated the attacks that were made upon him, including the one from which he died, the fatality of which was due to some awkwardness or blunder of his own. She rejects the idea of his having been a person of any importance. (Macmillan. Price, $1.50.)

In *Castorologia, or the History and Traditions of the Canadian Beaver*, Mr. *Horace T. Martin* has presented a popular monograph on that subject, in which he has endeavored to separate the tradition from the history, while giving each its due presentment. His book includes chapters on the mythology and folklore respecting the animal, Indian legends of giant beavers, and the mammoth beavers of geology; the European beavers; the more important American rodents; the life history of the Canadian beaver, its geographical distribution, its engineering accomplishments, the economical uses that are made of it, the chemico-medical properties of castoreum, the importance of the animal in trade and commerce, the uses made of it in manufactures, the hunting of it, Experiments in Domestication, its anatomy and osteology, and the Beaver in Heraldry—all handsomely illustrated. (Montreal, William Drysdale & Co.)

Mr. *D. W. Taylor's* book, largely mathematical, on the *Resistance of Ships and Screw Propulsion* originated in the author's own sense of the need of a treatise on the subject, containing data, formulas, and tables. Much of the material has been derived, necessarily, from papers read by the late William Froude, and R. E. Froude, his son, before the Institution of Naval Architects; and much of it is original. The author has intended to discuss ships as they are, not floating bodies in general; and to set forth methods and deduce results as sim-

ple as the nature of the subject will allow, and sufficiently accurate for every-day use. (Macmillan & Co. Price, $3.75.)

Helen Gilbert Ecob makes a plea for rational dress in *The Well-dressed Woman*, which she designates as a study in the practical application to dress of the laws of Health, Art, and Morals. The study is made in the light of scientific investigations of the injurious effect of certain features of modern dress upon the vital organs. Of these features the tight corset is the worst and most formidable; and several chapters are devoted to the exhibition of the ills it causes on the breathing, the liver, heart, circulation of the blood, stomach, and pelvic organs; while the feet and the proper fitting of the shoes are not forgotten. Physical culture is commended as authorized by the laws of our being, and as teaching muscular economy as well as muscular development; and "one great step toward physical restoration will be taken when women adopt a style of dress which allows diaphragmatic breathing and muscular freedom." But "the failure of reformers who have appealed only to the conscience of women shows that correct dress will be adopted only when it is made beautiful." The latter part of the book is therefore devoted to showing how this may be done. (Fowler and Wells Company, New York. Price, $1.)

The Bureau of Education has issued a Circular of Information on *Shorthand Instruction and Practice*, by *Julius Ensign Rockwell*, which is in part a revision of a similar circular issued in 1884, but with some new matter. One important addition is a digest of legal decisions in regard to shorthand writers. The statistics of the new volume are for the scholastic year ending June 30, 1890. We can not see why any part of the taxes paid by the people of the United States should have been used for publishing this book. In justification of the outlay it is stated in the letter submitting the publication to the Secretary of the Interior that of the earlier circular "an edition of twenty thousand was soon distributed, and was followed by another of equal size, which was exhausted in a few years, and for the past three years I may say that there have been more frequent calls for this circular than for any other published by the Bureau of Education." Now the people, represented by the Government, are supposed to publish only such useful books as have no money in them for private enterprise. But a book of which over forty thousand gratis copies are called for would doubtless sell to half that number at a price covering cost, royalty to the author, and a fair profit to the publisher. The persons to whom the book has value would pay for the copies, and those who have no interest in it would not be forced to contribute to the cost of producing it. In no case should a second or a revised edition of an inexpensive book for which there is a large demand be published by the Government.

Part XXIV of the *Proceedings of the Society for Psychical Research* (Paul, 3*s.* 6*d.*) contains three papers. Mr. F. W. H. Myers furnishes two chapters in continuation of his series on The Subliminal Consciousness, the first of which describes phenomena that seem to indicate the existence of a double personality, and the second brings together a considerable number of cases of thought-transference, under the head of Motor Automatism. The defense which the theosophists have made against the adverse verdict of the society upon their operations and claims is reviewed by Dr. Richard Hodgson. There is also a joint paper by A. T. Myers, M. D., and F. W. H. Myers on Mind Cure, Faith Cure, and the Miracles of Lourdes. Their provisional judgment on this class of cures is that no evidence of their being miraculous has been furnished, but that they produce, "by obscure but natural agencies, effects to which no definite limit can as yet be assigned." Dr. Hodgson, 5 Boylston Place, Boston, is the agent of the society in America.

Professors *James Harkness* and *Frank Morley* have published a *Treatise on the Theory of Functions* (Macmillan). The earlier chapters are made complete in themselves by including indispensable theories which are given by some, but not all, recent writers on algebra, trigonometry, the calculus, etc. The authors have aimed at a full presentation of the standard parts of the subject, with certain exceptions. Thus the theory of real functions of a real variable is given only so far as they deem necessary as a basis for what follows. In the account of Abelian integrals

their object has been to lead the student as simply and rapidly as possible into what is itself a suitable theme for more than one large volume. The automorphic functions have been entirely passed over, since it was not possible to give even an introductory sketch within the space available. However, an account of some of Kronecker's work, which is necessary for the study of Klein's recent developments of the theory of Abelian functions, is included, and one chapter is devoted to a treatment of double theta-functions, which goes further than the immediate purpose of the authors, for the reason that the subject is not very accessible in English. A glossary is added which gives the principal technical terms employed by German and French writers, with the adopted equivalents. There are also an index and a table of references.

The second volume of the *Treatise on the Mathematical Theory of Elasticity*, by *A. E. H. Love* (Macmillan, $3), has now been issued, the first volume having appeared a year ago. Volume II opens with a Historical Introduction, tracing the work of the two Bernouillis, Lagrange, Saint-Venant, Poisson, Kirchhoff, Thomson and Tait, Boussinesq, Clebsch, Rayleigh, and others. In the eleven chapters forming the body of the volume the author treats first the elasticity of thin rods, passes from this to thin plates and shells, and concludes with a chapter on the stability of elastic systems. There is an index to the present volume, and forty diagrams are employed in the text.

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POPULAR MISCELLANY.

Pestalozzianism in America.—An article under this title, by Mr. George W. Boutwell, in The Popular Science Monthly of November, 1893, undertakes to correct in one important point my article on the Oswego Normal School, in The Popular Science Monthly of the preceding May. I fully agree with Mr. Boutwell that Pestalozzian principles were known and discussed in this country long before the Oswego movement. This was implied in my article, if not distinctly stated. I did not state where, when, and by whom they were introduced, not because of a desire to detract from the honor due to Pestalozzian pioneers in Massachusetts or elsewhere in America, but because these matters were not directly within the scope of my article, and limitations of space did not permit excursions from the subject. It is claimed for Dr. Sheldon and his associates that they were the first to systematically apply Pestalozzian methods to a system of public schools in all its grades, and the first to give to teachers systematic training in these methods. This claim will, I believe, bear investigation, and will keep in honorable remembrance the work done at Oswego.—William M. Aber.

Prehistoric Trepanning.—A considerable number of examples of trepanning and of in-

struments used in the operation have been recovered from the prehistoric remains in different countries, the chronological dates of which range from the earliest neolithic age to historic times. Hippocrates was not a stranger to these processes, but performed them in cases of accidents to the skull, and even of headache. The Montenegrins submit to the operation; and it has been suggested as probable that in both instances the procedure is simply a custom surviving from primeval ages. A paper reviewing this subject, by Dr. Robert Munro, records a strange blending of medicine and theology in the earlier periods of this treatment, for he shows that during the neolithic period the operation was performed on children afflicted with certain internal maladies, and that the skulls of those who survived the treatment were considered possessed of special mystical qualities. When such persons died, fragments were often cut from their skulls and used as amulets; and pieces cut from the margin of the cicatrized opening were preferred. The process in prehistoric times was practiced chiefly on children, partly, probably, because it could be more easily accomplished upon them, and possibly, also, as an early precaution against certain supernatural and demoniac evils. The Chaldean magic, according to Lenormant, mentioned "the wicked demon which seizes the body, which disturbs the body," and taught that "the disease of the forehead proceeds from the infernal regions; it is come from the dwelling of the lord of the abyss." We have a right to suppose, in view of these evidences, as Broca has suggested, that many of the convulsions peculiar to children were regarded as the result of demoniacal possession. It would be natural, then, to try to assist the escape of the imprisoned spirit by boring a hole in the skull by which it was confined. The belief in the medicinal efficacy of cranial bones persisted till the beginning of the last century; and such bones have been worn in recent years by aged Italians as charms against epilepsy and other nervous diseases. When once the dogma was promulgated that sanctity and a perforated skull were correlated, fond relatives might bore the heads of the departed to facilitate the exodus of any malignant influence still lingering within, and to insure them, by the venerated aperture, a satisfactory position in their new existence. For similar reasons the bone was buried with the deceased, and sometimes it was even placed within his skull. Dr. Munro, while accepting Broca's view and amplifying upon it, suggests further that the post-mortem trepanning may have been such a pious endeavor to carry sacramental benefit beyond the grave as induced the early Christians to be baptized for the dead, and that it points to a belief in the supernatural and in the existence of a future state.

Prof. Huxley and the late Sir Andrew Clark.—Prof. Huxley has furnished the London Lancet with the following reminiscence of his first meeting and subsequent acquaintance with Sir Andrew Clark, the eminent English physician, who has recently died: "I was appointed assistant surgeon to H. M. S. Victory at Portsmouth in March, 1846, and was, in the ordinary course, detailed for duty at Haslar Hospital until such time as the Admiralty might be pleased to order me to join a seagoing ship. Some time after—I think two or three months—a young Scotchman joined our mess. He was very slender, of somewhat stooping carriage, and with that florid delicacy of complexion which commonly marks the *poitrinaire*. Most of us were tolerably vigorous young men, and we thought that our new colleague, Andrew Clark, had a good deal less prospect of standing the life that was probably in store for him than we had. In fact, he looked just the sort of man to die of consumption before the age of thirty-five. Now it so happened that three out of the small company of assistant surgeons at Haslar during the five months of my residence—Alexander Armstrong, John Watt Reid, and myself—were destined to prove our competency to go through a fair share of hard work, official and other; and it would have very much surprised us to hear that Clark was not only to work harder, but to go on working for years after we had been put upon our respective shelves as retired veterans. I doubt if a good deal more wisdom and experience than any of us possessed would have divined in our very quiet, and even retiring, young messmate the prodigious store of mental and physical energy upon which he was able to draw in later life; and I venture to be certain that, of all careers

imaginable, that of the most fashionable physician in London is the last that any one, however sagacious, would have predicted for him. I went my way to the other side of the world, for four years, in the fall of 1846, and, after my return to England, the kindly fates determined I should no longer be exposed to the risk of committing homicide as a grievously incompetent member of the noblest of professions. So my former messmate and I drifted far away from one another on our several courses, and only indirect accounts of him reached me from time to time. I heard that destiny had withdrawn him from the service, no doubt for reasons directly opposite to those which led to my removal; then, that he was practicing in some far-off region of London, eastward of the fashionable Eden; then, as it seemed quite suddenly, I learned that he was a hospital physician of great repute and rapidly increasing practice, residing in the very omphalos of Æsculapia —Cavendish Square. We met now and again, as busy men in London do; but I suppose our renewed acquaintance would have stopped there, had I not fallen ill in 1871 of what it was then the fashion to call overwork. I was desired to rest, go to Egypt, and do all sorts of other things; which I did, but with no other result than that of gradually descending into lower and lower circles of the inferno of hypochondriacal dyspepsia. After a year or more of this increasing wretchedness, a friend fairly worried me into consulting the doctor who was all the fashion, and who, I confess, seemed nowise the better in my eyes for being so. It is difficult for me to speak in moderate language of the time and pains which one of the hardest-pressed of physicians devoted to my case; of his thoughtful and self-sacrificing care not only of me, but of several members of my family; of the scientific sagacity of his diagnosis; or of the firmness with which he insisted on somewhat ascetic remedial measures which, in the opinion of not a few of my friends, tended to speedy euthanasia. Suffice it to say that I was practically well in three months, and remained in a very good state of repair for a dozen years. From that time onward we were fast friends, none the less for heartily disagreeing about a good many fundamental questions. Thoughtless people blame Sir Andrew Clark for not leaving off work when he had reached wealth, fame, and the official headship of his profession. But though he may have liked these rewards as well as another, my friend did not live for them. His work was his life, and no true friend would have desired for him, of all men, a prolongation of that shadow-life of enforced rest, in which there is no repose."

Action of Light on Dyes.—The report of the British Association's committee on the action of light on dyed colors refers chiefly to coloring matters belonging to groups of dyes known as eosins, rosanilines, indulines, and azo colors, producing various shades of red. The results show that relative fastness or permanence of the colors when exposed to light is practically the same on silk as on wool. The most fugitive red dyes are those of the eosin group and their allies, while the most permanent, with very few exceptions, belong to the group of azo colors. One very important result is that the rate of fading of a dye depends mainly on its chemical constitution, and does not depend upon whether it is an artificial or a natural product. It follows that, contrary to the common belief, artificial coloring matters are made that are quite as permanent when exposed to light as the colors obtained directly from vegetable products.

Guesses and Proof.—Dr. Pye-Smith, in the course of the last Harveian oration, delivered in London in October, said: "As Paley justly puts it, 'He only discovers who proves.' To hit upon the true conjecture here and there amid a crowd of untrue guesses, and leave it again without appreciation of its importance, is as a sign, not of intelligence, but of frivolity. We are told that of the seven wise men of Greece one—I believe it was Thales—taught that the sun did not go around the earth, but the earth around the sun, and hence it has been said that Thales anticipated Copernicus—a flagrant example of the fallacy in question. A crowd of idle philosophers, who sat through the long summer days and nights of Attica discussing all things in heaven and earth, must sometimes have hit upon a true opinion, if only by accident; but Thales, or whoever broached the heliocentric dogma, had

no reason for his belief, and showed himself not more but less reasonable than his companions. The crude theories and gross absurdities of phrenology are not in the least justified or excused by the present knowledge of cerebral localization; nor do the baseless speculations of Lamarck or Erasmus Darwin entitle them to be regarded as the forerunners of Erasmus Darwin's illustrious grandson. Up to 1859 impartial and competent men were bound to disbelieve in evolution; after that date, or at least so soon as the facts and arguments of Darwin and Wallace had been published, they were equally bound to believe in it. He discovers who proves, and by this test Harvey is the sole and absolute discoverer of the movements of the heart and of the blood."

Habits of Scorpions.—A study is contributed to Nature by Mr. R. J. Pocock, of the habits of living scorpions. They were made upon the two species *Parabuthus capensis* and *Euscorpius carpathicus*. The specimens were evidently nocturnal, spending the daytime huddled together in the corners of their box, or under pieces of wood, and wandering about at night. "It was easy, however, at any time during the day to rouse them from their sluggishness by applying a little artificial warmth to the box." If the warmth was very moderate, they would seek it and bask in it; but as it increased, even while the author could bear it for several minutes without inconvenience upon his hand, "they were at once in a state of consternation." While walking, both species carried their pincers well in advance of the head, where they served as feelers. *Euscorpius* dragged its tail along the ground; *Parabuthus* carried his, curled in a vertical plane, over the hinder part of the back. All scorpions appear to be carnivorous, and to live principally on insects or other articulated animals, but the species differ considerably in their choice of food from the variety offered them. "As soon as a cockroach is seized the use of the scorpion's tail is seen; for this organ is brought rapidly over the latter's back, and the point of the sting is thrust into the insect. The poison instilled into the wound thus made, although not causing immediate death, has a paralyzing effect upon the muscles, and quickly deprives the insect of struggling powers, and consequently of all chance of escape. If the insect, however, is a small one—one, in fact, that can be easily held in the pincers, and eaten without trouble while alive—a scorpion does not always waste poison upon it." The only one of the higher senses that seems to be highly developed is that of touch. M. L. Becker says that that sense and hearing are excessively developed, but Mr. Pocock finds no evidence of auditory organs, and the sight very poor. The external organs of touch are the hairs that thickly or sparingly cover various parts of the body; and the pectine or ventral combs appear to play an important part in this office. The stinging by a scorpion is not a random thrust, delivered indiscriminately at any part of a captured insect. The scorpion "generally feels carefully for a soft spot, and then with an air of great deliberation delicately inserts its sting into it. There can be little doubt that this care is taken that there may be no risk of damaging the point of the sting against a substance too hard for it. . . . The same care of the sting is shown in the carriage of the tail, this organ being curled in such a way that the point can not come in contact with any foreign bodies. Even when turned with a piece of stick, or irritated by being crawled upon by a cockroach, a scorpion is not often sufficiently provoked to use its sting. The tail is certainly used to knock aside the instrument or sweep off the insect, but the sides or lower surface of the organ are employed, the vesicle being carefully tucked down." The author did not find his scorpions so pugnacious as they are generally said to be, and he doubts if they ever deliberately commit suicide, though they may do so accidentally, or in desperation.

The Blue Mountains of Jamaica.—The first object that greets the eye of the voyager, as he nears the shores of Jamaica, says Commissioner Charles A. Ward, in his account of the island prepared for the Chicago Exposition, is the mass of dark blue mountain looming upon the horizon; and as he draws nearer and nearer, though peak and ridge assume clearer and more distinct shapes, each still retains the tint of deep azure that gives its name to the chain.

From its highest point, 7,500 feet above the sea, it throws out branches north and south, which now open into alluvial plain, now descend sheer into the girdle of warm blue sea that encircles the island. The trip to the highest point—Blue Mountain Peak—is one of two days, the night being spent in a hut on the summit. Provisions must be laid in and guides procured, who will also serve as porters. The road mounts ridge after ridge, winds down steep descents, crosses the streams that rush down every gorge, skirts along the slopes and goes over the tops of the intervening hills, and now and then leaves one valley and follows the course of another. An easy ride of about four hours brings the traveler to Farm Hill Coffee Plantation, where the keys of the hut on the summit may be obtained. The road then winds along past Whitfield Hall to Abbey Green, whose houses and terraces of solid masonry are perched on slopes so steep that they appear in imminent danger of tumbling into the abyss beneath them. Behind this the road zigzags up the steep sides of the mountain, threading its course between fields of coffee, some of them of such venerable age that many of the bushes have assumed the appearance of dwarfed trees from the constant lopping and pruning, with trunks from six to nine inches in diameter, and only about four feet high. The leaves of cinchona, blotched with scarlet, now add their quota of color to the scene, for we are leaving the coffee region and reaching the elevation at which this plant best flourishes. Hundreds of acres were planted here some fifteen years ago, but their cultivation is less profitable now, and the cinchona runs wild and self-sown, growing in rank thickets. At the top of the peak, about two hours from Farm Hill, is a small open space covered with soft, springy turf and fringed with stunted trees, at one side of which stands a little hut of two rooms. It has a stove and a supply of fire-wood, which can be used on condition of replacing the wood before leaving—a most rigidly observed point of peak etiquette. South of the hut is a narrow track leading down a precipitous ravine, near which is a small pool of water sufficient for one's absolute needs—except in extraordinarily dry weather, when it fails. The thermometer sometimes falls to 40° Fahr., and solid ice was once found on the summit during a wave of unusual cold. Only one of the peaks—Sir John's Peak, which is 6,100 feet high—approaches within 2,000 feet of the altitude of this one. The southern and western slopes of the range are largely cultivated with coffee and inhabited.

Concurrence of Parts in the Living Organism.—The presidential address of Dr. J. S. Burdon Sanderson at the British Association was devoted to the exposition of the character and scope of biology. Aristotle was named as the true father and founder of the science, while the name was given to it by Treviranus. He conceived the difference between vital and physical processes to lie, not in the nature of the processes themselves, but in their co ordination—that is, in their adaptedness to a given purpose, and to the peculiar and special relation in which the organism stands to the external world. His conception, the speaker declared, "can still be accepted as true." It suggests the idea of organism as that to which all other biological ideas must relate. It also suggests, although perhaps it does not express it, that action is not an attribute of the organism but of its essence; that if, on the one hand, protoplasm is the basis of life, life is the basis of protoplasm. Their relations to each other are reciprocal. We think of the visible structure only in connection with the invisible process." It is also of value as indicating at once the two lines of inquiry into which the science has been divided by the evolution of knowledge. These two lines may be easily deduced from the general principle from which Treviranus started, according to which it is the fundamental characteristic of the organism that all that goes on in it is to the advantage of the whole. This conception has at all times presented itself in the minds of those who have sought to understand the distinction between living and non-living. It was expressed by the physiologists of three hundred years ago by the term *consensus partium*—which was defined as the concurrence of parts in action, of such a nature that each does its share, all combining to bring about one effect, "as if they had been in secret council, but at the same time by some constant law of Nature." It means

that, regarding a plant or an animal as an organism, we concern ourselves primarily with its activities or its energies. These are naturally distinguishable into two kinds, according as we consider the action of the whole organism in its relation to the external world or to other organisms, or the action of the parts or organs in their relation to each other. This distinction has always existed, but has only lately come into such prominence that it divides biologists into two camps—those who make it their aim to investigate the action of the organism and its parts by the accepted methods of physics and chemistry; and those who interest themselves rather in considering the place which each organism occupies and the part it plays in the economy of Nature.

A Year's Work in Physics.—Among the notable papers of the year resulting from studies in physics, Mr. R. T. Glazebrook, sectional president in the British Association, mentioned Mr. E. R. Griffith's redetermination of the mechanical equivalent of heat—a work which it has taken five years to complete. With the exception of one group of experiments the results differ by less than one part in ten thousand. During his investigation Mr. Griffith proved an exact accordance between the scale of temperature as determined by comparing his platinum thermometer with the air thermometer made in 1890 by Callendar and himself, and that of the nitrogen thermometer of the Bureau International at Sèvres. Among other long investigations completed during the year was Rowland's Table of Standard Wave Lengths. The photographic map of the solar spectrum taken by Mr. Riggs with a Rowland grating was also finished. Lord Rayleigh's paper on the Intensity of Light reflected from Water and Mercury at nearly perpendicular incidence, combined with the experiments on reflection from liquid surfaces in the neighborhood of the polarizing angle, establishes results of the utmost importance in optical theory. "There is," says Lord Rayleigh, "no experimental evidence against the rigorous application of Fresnel's formula—for the reflection of polarized light—to the ideal case of an abrupt transition between two uniform transparent media." Prof. Dewar has continued his experiments on the liquefaction of oxygen and nitrogen on a large scale. To a physicist perhaps the most important results of the research are the discovery of the magnetic properties of liquid oxygen, and the proof of the fact that the resistance of certain pure metals vanishes at absolute zero. The last discovery is borne out by Griffiths and Callendar's experiments with their platinum thermometers. Mr. Williams's article on the Relation of the Dimensions of Physical Quantities to Directions in Space led to an interesting discussion.

The Polar Basin.—In his presidential address before the Geographical Section of the British Association Mr. Henry Seebohm, after stating that the foundation of all geography is exploration, and that its scientific study requires a knowledge of cartography and of meteorology or climatology, elaborated these subjects in detail, taking the polar basin as an example. There is, he said, only one polar basin; the relative distribution of land and water and the geographical distribution of light and heat in the arctic region are absolutely unique. In no other part of the world is a similar climate to be found. The distribution of land and water round the south pole is almost the converse of that round the north pole. In the one we have a mountain of snow and ice covering a lofty mass of congealed water surrounded by an ocean stretching away with very little interruption from land to the confines of the tropics. In the other we have a basin of water surrounding a comparatively flat plain of pack ice, some of which is probably permanent (the so called palæocrystic sea), but most of which is driven hither and thither in summer by winds and currents, and is walled in by continental and island barriers broken only by the narrow outlets of Bering Strait and Baffin's Bay, and the broader gulf which leads to the Atlantic Ocean, and even that interrupted by Iceland, Spitzbergen, and Franz Josef Land. If we assume that the unknown regions are principally sea, then the polar basin, including the area drained by all rivers flowing into the Arctic Sea, may be roughly estimated to contain about 14,000,000 square miles, of which half is land and half water. In the coldest part of the basin the land is either glacier or tundra,

and in the warmer parts it is either forest or steppe. Greenland, the home of the glacier and the mother of the icebergs of the Northern Atlantic, rises 9,000 or 10,000 feet above the sea level, while the sea between that lofty plateau and Scandinavia is the deepest known in the polar basin, though it is separated from the rest of the Atlantic by a broad belt or submarine plateau connecting Greenland across Iceland and the Faroes with the British Islands and Europe. Iceland, Spitzbergen, and Novaya-Zemlia, the latter a continuation of the Urals, are all mountainous and full of glaciers. The glaciers of southern Alaska are some of the largest in the world.

Aspects of the Antarctic Regions.—The subject of antarctic exploration was discussed at the meeting of the British Association. Mr. W. S. Bruce contributed Notes of an Antarctic Voyage. Dr. C. M. Donald, reporting some observations made on the voyage, said that the antarctic regions differ in many respects from the arctic regions, the differences arising probably from diversities in geological structure. Bird life is scant in the south, and the birds are of different kinds from those of the north. The icebergs, too, instead of being rugged and irregular, are plateau-shaped, rising with straight sides about two hundred and fifty feet from the water, and often of vast extent. One was met thirty miles long. Two of the steamers of the expedition worked through the pack ice—impenetrable to a sailing ship—and approached the sixty-fifth parallel. Mr. Seebohm described the penguin as being, with the exception of a few petrels, almost the only bird found in the ntarctic aregions. Penguins were so different from all other birds that some had divided the order into penguins and not-penguins. The penguin was found almost to the equator; not only where there is a cold current. The Australian Antarctic Expedition, much talked of a few years ago, is in a state of suspense on account of the difficulty of obtaining the money needed.

The Place of Geology in Education.—In the discussion, in the British Association, of the Place of Geology in Secondary and Professional Education, Prof. Greenville A. J. Cole urged that geology formed a subject of such far-reaching importance that it should be included in the general course for boys and girls of about the age of sixteen or seventeen. Every one should be capable of appreciating his surroundings, and particularly the past history of life upon the globe, if he was to be able to pass judgment upon current affairs and to play his part as an individual organism. Geology was as fundamentally important as history, and tended to modify very largely our conceptions of the relations between what is called antiquity and ourselves. In common with other natural sciences it encouraged a love of truth where statements could be safely made, and of reserve where assertions would be merely dogmatic. The course suggested for all pupils was one in which mineral details were subordinated, except where they were important in explaining the origin of certain broad features, such as familiar and local landscapes. The greatest stress for general purposes was to be laid upon an outline of stratigraphical geology and its illustration by such beds, unconformities, etc., as might be exhibited in the environs of the school. The outdoor character of the study should be insisted on; and the fact that the broader generalizations of the science were based on the collation of local observations would not be among the least valuable results of the introduction of the subject into our educational systems. Prof. G. A. Lebour thought that in teaching geology to students destined to be engineers or to have charge of mines it was desirable that they should have such a knowledge of the subject as would enable them, not to solve problems, but to understand the grounds on which experts base their reports.

Finger Marks.—In the British Association Mr. Francis Galton gave a description of his system of finger-print impressions which had been recently introduced into the Indian army. There is affixed to the nominal roll an impression in ink of the fore, middle, and ring fingers of the right hand of each recruit. This plan is found very useful as a check upon personation. Sir William Herschel used the method with success in Bengal for many years. If a clear impression with the finger tips were made, there

would be obtained between thirty and forty bifurcations or ridges which were absolutely persistent through life. For purposes of identification the impression of three fingers would be sufficient, but for purposes of registration it was desirable to take the whole ten. It was suggested that this method might be adopted in the case of illiterates instead of making the usual cross-mark as a signature to legal documents. The President of the Anthropological Section said that this method was used by prehistoric man for purposes of ornamentation.

A Scheme of Education.—In one of his Johns Hopkins University lectures on the Philosophy of Education, Prof. W. T. Harris marks three epochs of school education—the elementary, secondary, and higher; of which the first or elementary stage is the opening of the "five windows" of the soul: arithmetic, the foundation of our knowledge of Nature, by which we measure and count all things inorganic; elementary geography, by which the distribution of animal and plant life is learned; reading and writing, which give a glimpse into literature; grammar; and history (of the pupil's own country). Literature, says the author, "lifts up the pupil into the realms of human nature and discloses the motives which govern the actions of men." In history, one sees "revealed the aspirations of his countrymen, his own nature, written out in colossal letters." The secondary education takes up human learning and continues it along the same lines—namely, inorganic Nature, organic Nature, literature (the heart), grammar and logic (the intellect), and history (the will). Algebra deals in general numbers, geometry and physics continue inorganic Nature, while natural history continues the study already begun in geography. Then come Greek and Latin, "and here is opened up a great field of study into the embryology of our civilization. In the dead languages we have the three great threads running through the history of our civilization. The Greek, with its literature and æsthetic art and philosophy, shows the higher forms of human freedom; the Roman seeks the true forms of contracts and treaties and corporations; and the Hebrew thread is the religious one. So with the secondary education we begin to get the embryology of our forms of life." The higher or collegiate education is the comparative step. Each branch is studied in the light of all the others. The first or elementary education, then, is but superficial, a mere inventory; the secondary insists on some reflection on what has been learned; and the third or higher education is the unity and comparison of all that has been learned, so that each is explained by the whole.

Mineral Resources of Missouri.—The territory occupied by the State of Missouri, according to a report by Arthur Winslow, State Geologist, has been known as a mineral-producing area for nearly two hundred years. Penicaut, one of Le Sueur's party, which ascended the Mississippi River in 1700, refers to a mine west of the Mississippi and west of Sainte Genevieve, whence the Indians got their supply of lead. This indicates with reasonable certainty the date when the French began to make use of the mineral resources of the region. Iron mining was begun about 1815. Records of the existence of coal date from 1804; in 1840, 8,903 tons were mined, and production has since been continuous. Zinc was mined with lead ores for many years, but was not utilized till 1869. Since then the growth of production has been rapid. The principal mineral products of Missouri are zinc, in respect to which the State ranks first in the country; lead, in which it is second only to Colorado, and iron. In addition, Missouri is a large producer of coal, its clays have a national reputation, and it has a great variety of excellent building and ornamental stones. Among the minor products are quicklime, glass sands, copper, and baryta. Several of the more common classes of mineral waters are scattered all over the State. The zinc region is in the extreme southwest; lead is known to occur in thirty or more counties, and was mined during the past year in fourteen. Iron mining is confined to a part of the State south of the Missouri River and east of the marginal line of the coal measures. Of the four prominent mineral products of the State coal is the most widespread. Clays suitable for all ordinary uses are very abundant. Building stones are plentiful for home use, and shipments are made from many of the quarries

to foreign points. They include marbles, sandstones of excellent quality, and the Mexican "onyx" (arragonite, or carbonate of lime). Sands suitable for the manufacture of glass are abundant in the eastern part of the State. Silver occurs at one place, but the mine has been abandoned.

Prospects of Negro Education.—The problem of the comparative intellectual or ethical capacities of the Caucasian and the negro is treated by Dr. J. L. M. Curry, chairman of the Executive Committee of the John F. Slater Fund, as a speculative question that need not be studied as yet. What is called the "negro problem" is remote from its final or satisfactory solution. To settle it will require more than the thirty years that have elapsed since the Proclamation of Emancipation and more data and calmer and more scientific generalizations—free, too, from prejudice, fanaticism, sectarianism, and partisanship—than are yet at hand. The education of the negro is encompassed with peculiar complications, difficulties, and limitations. What has been accomplished is encouragement to do more. What has been attained is the demonstration that other and better things can be reached. In adopting means and methods to secure the highest results in education it must not be forgotten that the negro is still fettered by the heredity of thousands of years and by the ingrained and slowly eradicable weaknesses of slavery. It is proper to remember that African slavery has strengthened the necessary evils of the "peculiar institution" into habitudes, and that these in the course of years have become racial characteristics. Conferences were held during the last year, at which the normal and material condition of the negroes and the obstacles to their progress, the methods and means of progress, and the influence of women were discussed. Unquestionable as has been the improvement in normal and industrial work in the schools, it is equally beyond question that the instruction is not what it should be in any of them. What is called normal instruction is too often of very superficial character and a mere annex to the ordinary literary course, while what is done in manual training is unscientific and based apparently on merely utilitarian considerations. The Slater Fund has heretofore been operated in connection with the denominational and other schools already established in the South. While its managers have sought to emphasize as much as possible its peculiar objects of normal and manual training, it could not interfere with their objects or expect them to subordinate them to its purpose. The Hampton and Tuskegee Schools and the one at Montgomery are, however, not under these embarrassing conditions. A proposition is now before the trustees for establishing or aiding in establishing an independent school in which the purposes of the fund shall be predominant. The amount of the fund is $1,220,375.

NOTES.

A Correction.—The article on Vegetable Diet, by Lady Walb. Paget, which appeared in the Monthly for November, 1893, was reprinted from the Nineteenth Century, to which magazine it should have been credited.

The Franklin Institute, Philadelphia, has the awarding of certain medals for meritorious discoveries and inventions which will contribute to the promotion of arts and manufactures, as follows: The Elliott Cresson medal, gold, for some discovery in the arts and sciences, or for the invention and improvement of some useful machine, or for some new process or combination of materials in manufactures, or for ingenuity, skill, or perfection in workmanship; the John Scott Legacy Premium (twenty dollars) and medal, bronze, for useful inventions; and the Edward Longstreth medal of merit, silver, for useful invention, important discovery, and meritorious work in science or the industrial arts, or contributions to them. Persons desiring full information on the subject may correspond with William H. Wahl, secretary.

M. Dybowski, in a recent journey in the interior of Africa, encountered a tribe who have reduced cannibalism to such a system that they have only one object of purchase—slaves to be eaten. They refuse to sell food or any other products of their country for anything else, and the surrounding tribes capture and export canoe loads of slaves for this purpose.

Attention was recently called by M. Dollo in the Belgian Geological Society to some scientific conceptions of Dante. Thus there are references in the Commedia Divina, which was published about 1320, to the facts that the moon is the principal cause of the tides; that the surface of the sea is uniform except for the waves; that there exists a centripetal force, causing bodies to fall;

that the earth is spherical; that the land above the waters is only a protuberance on the surface of the globe; that the continents are grouped in the northern hemisphere; that there exists a universal attraction; that the elasticity of vapors is a motive power; that the continents have uprisen; and that chemical elements exist, more or less as Lavoisier conceived them.

The largest continuous distinct forest district in West Prussia is known as the Tucheler Haide, and extends over an area of thirty-five square miles. It is subject to great and sudden changes of temperature. Snow has fallen as late as May 19th, and night frosts have occurred as late as the 1st and 3d of June. Prehistoric remains are found belonging to the later stone and to the bronze ages. The inhabitants are occupied almost entirely with forestry and agriculture. Polish is still the prevalent language, though German is now generally understood.

As to the speed with which the migration flights of birds are accomplished, Canon Tristram, in the British Association, quoted Herr Gätke as maintaining that godwits and plovers can fly at the rate of 240 miles an hour. Dr. Jerdon had stated that the spine-tailed swift, roosting in Ceylon, would reach the Himalayas, a thousand miles, before sunset. In their ordinary flight the swift was the only bird the author had ever noticed to outstrip an express train on the Great Northern Railway.

Tobacco juice is very useful to agriculturists as a remedy for sheep mange and an insecticide, but its value is greatly lessened by its rapid fermentability. Experiments are making in the French Department of Manufactures for a process for concentrating an extract which shall be rich in nicotine and capable of indefinite preservation. A colorless extract is also sought which cultivators may use upon flowers attacked by insects.

Photographs of the invisible are what M. Zenger calls two pictures which he took about midnight of August 17th from a window looking out upon the lake of Geneva. They gave weak images of the lake and of Mont Blanc, which could not be seen in the darkness. Mr. Bertrand remarks that invisibility is a relative term, the significance of which depends on the power of the observer's eyes. The photographs were taken with a light of very small intensity, and did not represent an invisible object. So sky-photographs taken in observatories show stars which can not be discerned by the most piercing vision.

The absorption of light by platinum at different temperatures was the subject of a recent memoir to the Academy of Sciences of Turin by Signor Rizzo. The author obtained pellicles of unoxidizable platinum under the action of heat the transparency of which he found increased with the temperature, especially in the more refrangible regions. The determination of this fact establishes a new correlation between light and electricity, the augmentation of the electrical resistance of a conductor being accompanied by an increase of transparency.

An International Congress of Applied Chemistry has been called by the Belgian Association of Chemists, to meet in Brussels August 4, 1894. A number of interesting subjects appertaining to biological chemistry are to be considered, including those of the establishment of a Review of Reviews of Pure and Applied Biological Chemistry; pure yeast in practical fermentation; new researches of the relations of oxygen and yeast; raw grains in brewing; studies on the morphology and physiology of vinegar eels; analyses of grains as suitable for brewing, distilling, and the manufacture of glucose; and analysis of molasses with a view to distilling. Communications may be addressed to M. H. Van Laer, General Secretary of the Congress, 15 Rue de Holland, Brussels.

According to one of the latest visitors to the Ainus of Japan, Mr. A. H. Savage Landor, the supposed pious ejaculations, on the strength of which these people have been credited with a religious system, are really execrations.

An examination of the molluscan fauna that accumulate in the fresh-water pipes of Paris, brought there from the rivers whence the water is drawn, has been made by M. A. Locard, of Lyons. The author's attention was given chiefly to the study of the changes the animals undergo in their new abode. The medium differs from that of their native one in that it is one of water in perpetual motion, that food supply is scant, that the temperature is more constant than in open air, and that there is no light. Under these conditions the animals appear diminished in size, pale in color, somewhat elongated in shape, probably by the mechanical action of the running water, and with shells uniform, glossy, brilliant, without incrustations and without vegetable deposits. Though their presence contributes impurity to the water, it is not enough, under ordinary conditions, M. Locard believes, to do harm.

The schooner Ripple, in which the Swedish explorers Bjorling and Kalstennius started in 1892 on their expedition to study the fauna and flora of the arctic shores, has been found by Captain Mackey, of the Aurora, of Dundee, fast in the ice of Carey Island, Baffin Bay. The vessel had been cleared of boats and provisions, indicating that she had been abandoned. The dead body of a man was found in a cairn on the shore; and in another cairn close by were manuscripts written in English, with in-

structions to forward them to the nearest Swedish consul. The manuscripts have not been fully examined.

Prof. Frankland says that while the virility of many bacteria can be greatly reduced by successive cultivations, and the poisonous effects of such active bacteria as those of typhoid and cholera can be intensified by passing them repeatedly through the bodies of animals which at first offered great resistance to their pathogenic action, this increase in toxic effect can not be produced by artificial cultivation, and it has not been found possible to convert a harmless organism into a pathogenic one.

A curious case of resuscitation of an optical image has been described by Prof. T. Vignoli from his own experience. After a railway journey in a bright sun and two days' walking in the heat, he looked from the room in which he was engaged in conversation upon a balcony standing out in the bright sunlight. Early in the morning two days afterward, while lying awake in bed, he saw upon the ceiling an exact reproduction of the balcony, in all its colors and details. The image disappeared on closing the eyes, and reappeared on opening them again. Its appearance was not changed when it was regarded with one eye, looking with either alternately. It was interrupted by putting the finger in front of the eye, and responded in every respect to the usual features of ordinary vision. A cage of birds which hung upon the original balcony appeared, swinging as the real cage did.

What is undoubtedly the first publication of Asa Gray, although it is not included in the published lists of his writings, has been sent to Garden and Forest. It is a catalogue of the indigenous flowering and filicoid plants growing within twenty miles of Bridgewater, Oneida County, New York. It consists of nine pages, is dated January 1, 1833, or when the author was just in his twenty-fourth year, and is contained in the forty-second annual report of the Regents of the University of the State. It is also included in Prof. Britton's List of State and Local Floras of the United States and British America, where it is entered under Onondaga County.

Concerning his experience with horseshoes of aluminum, M. Japy reports that as that metal is four times lighter than iron a complete outfit of shoes of it will weigh no more than a single iron horseshoe. Horses accustomed to iron shoes when shod with shoes of aluminum imagine themselves barefooted, and are as careful in planting their steps as if they were unshod. The shoes open out as the hoof expands, and consequently never cramp it. An aluminum horseshoe will last from forty to sixty days, according to the composition of the alloy and the kind of work done by the horse. M. Japy concludes that aluminum can be utilized in shoes for race and carriage horses, and that it may be of service in the treatment of diseases of the hoof. It should, however, be used only by persons experienced in working the metal.

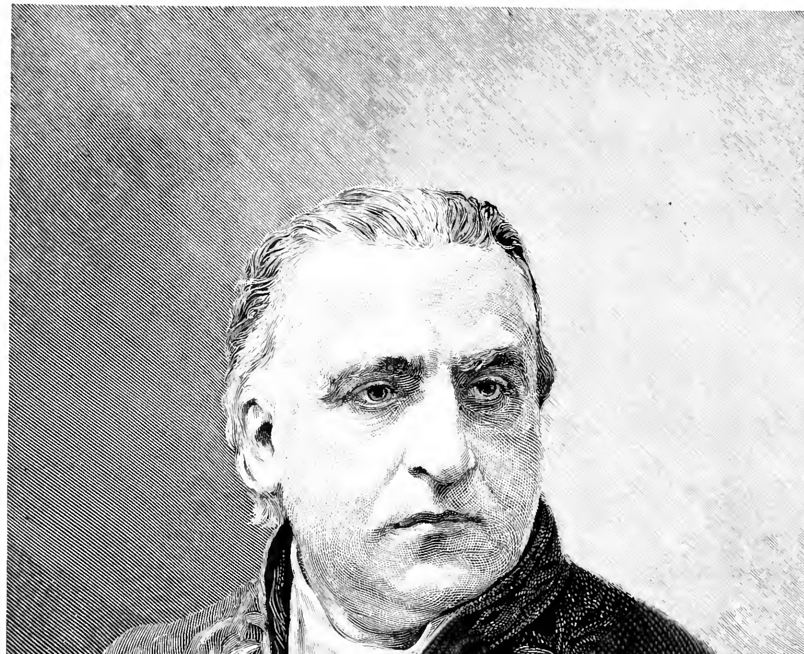
An instrument which he calls a formenophone has been invented by a French engineer, M. E. Hardy, for detecting the presence and estimating the proportions of gaseous impurities of an atmosphere by the sound they give in a pipe. It is based upon the principle that air passing through an organ pipe gives a definite and constant tone, while if any other gas is mixed with it the tone varies according to the gas and the quantity of it. Two instruments of similar construction are used—one arranged so that pure air, the other that the air to be measured shall be made to pass through pipes of identical construction.

The importance of taking thorough precautions in the case of animals dying of infectious disease is newly illustrated in an observation made by the Russian Diatroptoff. The water of a particular well was supposed to be the cause of an epidemic outbreak of anthrax among certain sheep. No contamination was found in the water, but the mud at the bottom of the well contained a microbe which produced anthrax on being inoculated into a sheep. The germs are supposed to have percolated through the soil to where they were found. The anthrax among the sheep ceased on the well being closed.

In a paper on Grinding and Polishing, Lord Rayleigh, after referring to the accuracy with which optical surfaces can be worked, said that the operation of grinding did not produce scratches on a glass surface, but that pits were cut into an otherwise plane surface by it. A surface so ground, when used for a lens, gave excellent definition, but great loss of light by irregular reflection. To remove this defect the lens had to be polished, by which operation the pits were gradually removed. He gave reasons for believing that in the process of polishing the glass was worn off molecularly, whereas grinding removes fragments of the glass. He found that in polishing a certain thin disk of glass a thickness equal to about six wave-lengths of yellow light was removed. It was easy to remove as small a depth as half a wave-length by means of hydrofluoric acid if proper precautions were taken.

Molds differ from bacteria, according to Prof. Frankland, in their action, and produce an oxidation, or burning up, instead of fermentation.

A new section, that of physiology, has been formed in the British Association. It is the ninth section, and will be designated by the letter I.



JEAN MARTIN CHARCOT.

THE

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ABOLISH ALL PROHIBITIVE LIQUOR LAWS.

By APPLETON MORGAN.

THE creation of crimes by means of statutes providing for their punishment has generally proved itself bad policy. In the days of Henry VIII it was the maxim that "a tinker was a rogue by statute"; and in Queen Elizabeth's time actors and "stage-players" were put into the same category as tinkers. But it came in time to be understood that the soldering of tin kettles was not a crime because a tinker here and there had robbed a hen-roost, and that the profession which had produced a Shakespeare was not, by any salutary public policy, a criminal profession.

The absolute, unqualified, and distinguished failure of all laws for the abolishment of the traffic in liquors is speedily convincing even the most sanguine prohibitionist of the expediency of wiping them from every statute-book in the land. Their failure has not been so much a protest against interference with the personal liberty of the citizen as an illustration of the venerable maxim that no law can exist without, or can survive, a reason for its existence. These laws, indeed, never had any adequate or logical reason for existing at all. They have had their origins always and without exception in sparsely settled communities where personal liberty was so absolute and unquestioned that it became irksome, where liquor was almost unknown and the user of it a curiosity, and where the only knowledge of the horrors of intoxication the village possessed was derived from itinerant temperance orators who dilated upon the terrible consequences of the rum habit to a roomful of tearful old women, none of whom knew the taste of liquor or of anything stronger than green tea. The early Puritans of New England, who enacted the most ferocious of blue

laws, who would not let a man step over a stone in his path or kiss—not his neighbor's, but his own—wife on a seventh day, no more thought of prohibiting the drinking of liquor than of prohibiting the preaching of eight and ten hours' sermons. When they settled a town, they built, first of all, a meeting house and, next to it, a jail. The jail was for those who did not want to go to the meeting house. But the pint of "new" rum per laborer in the hayfield was as much a matter of course as the minister's madeira or sherry, or the magistrate's metheglin or eggnog or toddy. In the wainscoting around every fireplace was the sunken toddy-shelf to be drawn out of evenings, and when a meeting house was to be raised, the community were expected to drink as freely as Heaven had blessed them in good things or the means to pay for them. So lately as 1804, when the frame of the new meeting house in Brimfield, Mass., was to be raised, the town voted $121.22 for "rum, sugar, brandy, lemons, and wine" for the occasion. And there are but few towns in Massachusetts that are smaller than Brimfield. The Puritans, in their courts of justice, cited edicts and precedents, not from the reporters, but from the Pentateuch, and sent men to the jail or to the gibbet according to the laws of Rehoboam or Jeroboam. But, because the sons of Rechab drank no wine or strong drink, it no more occurred to them to forego wine and strong drink themselves than it did to forsake their substantial frame dwellings and camp out because these same Rechabites had forsworn houses and lived in tents on the plains of Arabia thirty centuries previously!

Liquor is legitimately and logically a subject of excise, and excise laws, which may operate *in rem*—that is, against the thing itself—are proper and constitutional. But it would puzzle writers upon constitutional law to find an origin for laws prohibiting the manufacture or purchase or sale of an article of commerce, though laws regulating all three are neither unconstitutional nor improper. Besides unwritten and written or statute law, there is also what is called the "police power" of a state or a community, that is, the power of keeping the public peace. All three of these jurisdictions may deal with the individual out of whom too much liquor may have made a law-breaker. That is to say, the drunkard has fractured the unwritten or moral law by breaking the rule of temperance in all things. He has broken the written law by becoming a public nuisance or a public charge, and the police power of the State may lay hands upon him and lock him up for being disorderly, or for lying drunk and so blocking up the public streets that orderly persons may not pass and repass. But in what manner or form the commodity we call liquor has broken or come under the penal force of any one of these three jurisdictions, it is difficult to imagine; and, therefore, because this is a hard ques-

tion to answer, it is difficult to find a legal or logical origin for a prohibitory liquor law. Publicists assure us that all salutary laws and statutes which have proved to be for the general good are found to have invariably come from a demand for protection, or for warrant from an individual or a class asking either for protection or for franchise to benefit the state and himself by carrying on some useful business, art, or trade; or they have been enacted for the raising of revenue, or (as I have said above) for the conservation of the public peace. But not of such have been the origins of the various statutes against the selling of liquor which are borne on the statute-books of a great many, indeed of most of, our American States. These laws, when not copied *verbatim* or adopted substantially from other States—as the Kansas law was copied from the Maine law—have originated, not with a class of citizens who asked for protection, but with a class who proposed to protect some other class against its will. I fancy it would be difficult to find a prohibitive liquor law which was not in the first instance proposed by one who was himself either a teetotaler by preference, or one without himself any taste for anything stronger than water, and therefore without the slightest practical experience of the evils of intoxication; or by one whose knowledge of the terrors of liquor-drinking came at second hand from the description of the itinerant "temperance" orator; or possibly by witnessing the effects of the abuse of liquor upon some weaker-minded brother. In other words, it was exactly as if all the persons who preferred to go to bed at nine o'clock should revive the old law of curfew and get it back upon the statute-books; or, as if all those who loved to go to Sunday school should legislate to make it criminal not to go to Sunday school. So far as the records go (and I consult only those published by the prohibitionists themselves), not one single proposition for the policy of prohibiting the sales of liquor has originated from a demand for protection, or from cause of necessity, or even of expediency; or in a locality where the evils of such sales were apparent or largely experienced, or indeed experienced at all. In a rural community, however, absolutely without amusements, where personal liberty resembles, as somebody has well said, "the desolate freedom of the wild ass," and so becomes absolutely irksome—where a man with a theory or a crank with a hobby is welcome as a diversion—it is necessary to burrow in unusual paths for a relaxation. In such a precinct as this, a proposition to forbid somebody something, to prohibit something—it might be the wearing of crinoline or of birds in ladies' hats, or card playing, round dancing, Sunday newspapers, or the eating of animal food—anything, so long as it is something any one enjoys—will become fortuitously popular. Any one of the above would furnish a topic for conversation, a

call for a conference in the meeting house after singing school, might appear in the choice of a selectman, or in the election for the Assembly member, and so speedily become "practical politics," especially in a State where a Governor is chosen every year, and so which lives in a state of perpetual gubernatorial canvass! If laws preventing the sale of liquors should be demanded in a petition of those who used and habitually purchased liquor, but who desired to be relieved from the temptation of purchasing it, a wise public policy might have decreed that the petition prevail. Or, if the best sense of the most enlightened citizens of a community (and it is usually its most enlightened citizens who best appreciate the value and understand the judicious use of liquor) had felt the need of a law prohibiting the sale of cheap and poisonous adulterations of liquor to those who were unable to buy the pure article and whose healths were being deteriorated thereby—in any one of these cases these laws might have wisely been forthcoming, under a general pursuit of the greatest good for the greatest number. But for the non-users and non-purchasers of liquor, finding themselves in a majority, to resolve on their own motion that the minority of their fellow-citizens needed a protection, for which they had not asked, from temptations against which they had not protested, but which were not temptations to the majority, savors rather more of what old Butler characterized as "compounding sins one had a mind to by damning those ones not inclined to," than of legislation for the greatest good of the greatest number; of paternal rather than of popular government!

Once originated, however, the history of the paternal prohibitive liquor law is invariable—namely, its appearance in local politics, then in State politics, and so on, up to the dignity of a balance of power, where the numerical insignificance of the supporters became a tower of strength, and the supporters themselves grew to have fat things at their disposal. The earliest liquor law I can find, for example, grew out of some letters beginning on February 15, 1832, in a local newspaper* in Essex County, Massachusetts; certainly at that time one of the soberest, most law-abiding and church-going communities in the world; whence it was carried by one of the letter-writers, who became a member of the Maine Legislature, into that learned and economic body. If there was a State in our Union of States, at that date almost Arcadian in its innocence, where the foot of the tempter and the setter of snares, or the sybarite, or the debauchee were unknown, that State was Maine! And yet from the immaculate vicinage of Essex County, Massachusetts, to the virtuous State of

* The Salem Gazette.

Maine, the policy of prohibiting that which did not exist, of protecting the few from temptations which had no attractions to the many, flew on the wings of oratory and became fixed by the edicts of legislation. Into the older community, Essex County, it may be feared that Satan has entered! But the sovereign citizen of the State of Maine still lives on, in comic slavery to its prohibitory liquor law—a law indeed marvelous to behold, and a sight for the nations of the earth; alternately sending its citizens to jail for being free men, and rewarding them for becoming slaves! Under the malign influences of the Essex reform the State of Maine has introduced into its economy a new industry, that of the "smeller." Its extraordinary courts and constables and special magistrates, its bailiffs and petty officers who earn salaries on the pretense of enforcing laws which none of themselves, and probably no officers of the State or of its courts, from chief justice to tipstaff, thinks of observing, are legion. Of the published volumes of its reports the bulk are ponderous decisions on and expounding of its peculiar blue laws, which read between the lines like statutes of the Grand Duchy of Gerolstein! And for all this the intelligent citizens of Maine pay the bills and dodge the laws as well as they can! Sixty years or so ago, when the Essex law crawled into Maine, surely, as I have said, it was a virtuous and an Arcadian State. At present, whether it is more temperate than any of its sister States, whether there is less immorality, drunkenness, and crime therein than in any other State in the Union, the citizens of Maine are not fond of expressing an opinion, and doubtless the less said the better! It is to be added, moreover, that the Essex County letter-writers who thus builded better, or worse, than they knew, did not themselves propose a total prohibition from the sale of wines, ales, and other vinous or malt liquor, but one solely from the sale of ardent spirits, and of this only a mild restriction (a sort of "jug law")—that is, that spirits should be sold only to prevent the public drinking in rum-shops and bar-rooms, and the public spectacle of intoxication and brawling which so often resulted (and that what they sought is desirable to-day, as desirable as then, nobody can deny). But the idea that a gentleman who desired to use ardent spirits could not first purchase them, it is simple justice to the writers of the letters to say, did not present itself to them at all. When the matter got into the Maine Legislature, however, whether because the distinction between wines and liquors was too subtle or from other causes, that distinction disappeared. As the pure and simple prohibition of the sale of any liquor, even of domestic manufactured cider, it became a law; the prohibition has since been written into the Constitution of Maine itself, until that State has become a Commonwealth of law-breakers not only but of constitu-

tion-breakers, for the law against selling has become a law against manufacturing, and so against purchasing. And all these laws have been written in the Constitution of the State itself, and the citizens go on buying, selling, and purchasing, with a pretense of surreptitiousness that, comic as it all is, keeps buyer, seller, retailer, and purchaser alike in breach of the statutes *in sæcula sæculorum!*

But, from whatever source or sources ingrafted upon a long-suffering community, no honest student of these laws can deny that they have had one of three effects, if not all three of them—namely, (1) to increase the demand for, while deteriorating the quality of, the supply of liquors; (2) to stimulate the ingenuity of the subject in evading the law itself, if not to produce the appetite for liquor drinking where it existed not before; or (3) to give to the visionary or "crank" class in a community political balance of power—that is, an absolute even if a temporary power. In other words, prohibitory liquor laws are dangerous to the physical, moral, and political health of a community: to the physical health, by inducing venders who can not afford to sell pure liquor at the risk of the penalty, but who can not well resist the temptation in view of the enormous profits of selling cheap and vile mixtures at the enhanced prices for pure liquor, to keep their poisons on sale; to the moral health, by making honest men law-breakers (with the dangerous tendency of the law-breaker *in petto* toward law-breaking *in extenso*, which the writers of moral poetry, from Dr. Watts up, have versified about until the memory of man runneth not to the contrary); and to the political health, by putting power into the hands of dangerous classes, the theorists, the "cranks," and the people with "missions" and visions as to reforming the world! (It might be added, perhaps, that these laws offend the religious sense, for in some States, as in Maine and in Kansas, the use of wine for the sacrament has been held a violation of law. But this aspect we are not at present discussing.) And all this in addition to the fact that prohibitory liquor laws are, always and everywhere, an infringement of the liberty of the subject, in opposition to the inalienable rights of life, liberty, and the pursuit of happiness which it is the business of constitutions to decree and of States to secure.

Drunkenness is a crime in itself and the fruitful mother of other crimes, and with it the criminal law should deal. But no commercial law or municipal law, no form of civil (as distinguished from criminal) law has anything to do with crimes. The legal maxim, as old as civilization, that one must so use his own as not to injure his neighbor, takes ample care of the liquor-seller who sells liquor to one who he knows will do violence or wrong under its influence. Let the criminal law, then, attend to

the case of the drunkard and of the rumseller who will knowingly make his feeble or hereditarily weak fellow-man a drunkard. But as there is no commandment in the decalogue, "Thou shalt not sell liquor," it is not in the unwritten law, and so can not justly, equitably, or legally be put into written law. That it is ever put there means some ulterior object, or if not an ulterior object always, certainly always it means, because it always has, an ulterior effect.

But prohibitory liquor laws have still another and ulterior effect, to wit: They beget an exaggerated oratory and an appetite for sweeping statements which, by the cultivation of false statistics, becomes absolute dishonesty, and so a burden upon and a reproach to public morals. For it is quite as heinous a sin, in the court of conscience, to lie about the number of persons who have died from using liquor as it is to lie about the amount of one's collections for charity, as did Ananias, or about the value of one's farm to the autumnal assessor. And yet another, more of an economical than a moral consequence, perhaps, might be catalogued. It has become in some communities practically impossible to discuss certain important questions. For example, it is to-day practically impossible in many quarters of this fair land to discuss so important a question as the effect of alcoholic liquors upon the human system. Impossible, I say, for no sooner is such a question broached than the most tropical statements, backed by the glassy fascination of enormous round numbers, would be hurled at the general public until the modest man of science, and science itself, are put to rout. This writer himself heard, in the Columbian year and from a Columbian orator, the following masterpiece of statement, to wit: "The champions of slavery, having declared their purpose to shatter the Union, withdrew from Washington and opened fire from without. Not so the liquor power. It plants its cannon, charged with hell's dynamite (enough of them to stretch in a line from this spot to the homes, the churches, the schools of the people); and there, sheltered and protected by the strong arm of the Government, the work of destruction goes mightily on among Americans; every five years there is an array of dead as a consequence equal in number to those killed on both sides in the civil war." By a coincidence, these words were uttered at a time when the courts of the State of New York had been several months, and at an expense of several hundred thousand dollars' worth of high-priced expert testimony, trying to ascertain whether Mrs. Carlyle Harris died of morphine poisoning, and was beginning to make an equal outlay to find if Mrs. Dr. Buchanan had died from the effect of morphine or atropine. And yet, here and meanwhile, this glowing orator announced that not one more nor one less than a million human beings had, in the

five years past, perished from being poisoned by liquor—by alcohol, an extremely mild toxicant that in some form or other chemists tell us exists in almost all our food, solid or liquid! Did it not, perhaps, occur to the orator, or possibly to another of his audience besides the present writer, that in the million of cases assured, say in two or three, even in one of them, a latent or contributing cause might possibly have mitigated the responsibility of this murderous alcohol; that one of those million of men may have been, perhaps, indiscreet in something else besides drinking beer, or had somewhere latent in his system some congenital or local contributive cause; or perhaps had met with some accidental incident to his alleged untimely taking off?

But this is a single sample only of the intemperance, not to say the voluptuous dalliance with tropical statistics, of the prohibition orator, who asserts that liquor has slain more than wild beasts, than wars, pestilences, famines and even deluges and Johnstown floods (which latter, by the way, were bursts of water and not of alcohol, which therefore has not, even in the mouths of prohibition orators, achieved the record of water, which certainly did wreck Johnstown, and which, according to Holy Writ, in one case did actually destroy the whole world). Indeed, nothing is more common upon their lips than the maxim "Liquor destroys both body and soul." But if the annual deaths actually and beyond question traceable to liquor were arrayed against the annual mortality (which is said to be a constant figure indifferently as to wars, famines, tidal waves, and the like cataclysma), it might be disputed as above if liquor always destroys the body, while as to the soul what mortal can depose and say? The danger of the tropical statement which appears to be inseparable from prohibition politics, however, is a very great one. Falsehood is falsehood and lying is lying, even in the mouths of lecturers and reformers; and temperance is a cardinal virtue in speech as well as in liquor drinking. Were such opulent misrepresentation and dishonesty confined only to the so-called "temperance" orators or "reformers," it would be bad enough, as teaching looseness and unreliability of statement and an irresponsibility of language, which would be and is dangerous to any community at large. But not only the tramp and the circulating itinerant, but eminent men, men of brains and personal worth, whose influence for good in their own neighborhood might be very large, are often so warped in their very fiber by this sort of misfortune as to become incapable of seeing things as they are—dealers in untruth, wrapped in untruth as in a garment. I have in mind one eminent gentleman, a man of large affairs and of otherwise unblemished integrity, who has the misfortune of being a prohibitionist leader, and

the author and supporter of many prohibitionist statutes. As the standing chairman of a committee in the Legislature of a certain State to report annually as to the value and the operation of these statutes, his reports are invariably enthusiastic as to their great value, as to their effect in closing liquor stores, and in making drunkenness almost unknown. And this in the teeth of the facts, which everybody else admits, that these statutes are stupendous failures, that they have multiplied the number of liquor shops, and added to whatever harm they are capable of by disguising them as "pharmacies," "groceries," or other sorts of shops, and that they have enormously increased, almost squared, the number of inebriates reported before their passage! Nobody impeaches or dreams of impeaching the statements of this dear old gentleman, nameless here for evermore, who, foolish and fond and lovingly proud of his statutes, can see nothing but utility and salvation in them! But, all the same, it is an actual wrong, and in time it will be surely an actual damage to the Commonwealth that its intelligent citizens can so deliberately misstate facts. If its best citizens can not tell the truth on public matters, what can the Commonwealth expect of its masses?

But everybody knows that drunkenness is a curse, and if we abolish all prohibitive liquor laws how shall the curse be removed? To enact a law compelling every man, woman, and child to drink a pint of whisky—or its equivalent in other spirits, or in vinous, or malt liquors—daily, might indeed do it. But such a law would probably be impossible to propose in a legislative body—certainly impossible to pass to a final reading. The question can not probably be answered at present. Most things, however, have their limit of value. And it might be a question whether even the soul of a drunkard were worth saving at the expense of the liberty, the morals, and the health of an entire community. But something very near to an answer can, I think, be approximated. Let us enforce the common law we have, and make it "common" indeed; and forbear to pass statutes against which the sense of justice of the enlightened community rebels, and which can not be enforced, or whose enforcement is only, and can in the nature of things be only, a sham. Let us wipe out forever from every statute-book in America those prohibitive liquor laws which an experience of sixty years has proved to be worse than worthless, and even worse than useless, because they not only can not be enforced, but enlarge, by stimulating, the alleged evils they pretend to abolish! These laws emphatically have not lessened the manufacture, sale, or consumption of liquor. There are not to-day ten times as many people in the country as there were on January 15, 1832. But, unless figures are as unreliable as the temperance orators themselves, there are many hundred times as

many liquor stores and shops for the public drinking of liquor in our fair land as there were upon that date. Various causes have doubtless operated to produce this enormous increase. But one cause which may have done its contributive share toward the result, perhaps, is that, under rigid statutes, any moral obligation not to use liquor which may have existed on January 15, 1832, has become a sort of moral obligation to use it as a sort of Declaration of Independence of laws which interfere with the personal liberty of the subject; which exist not by consent of those whom those laws govern, but by the consent of those whom they do not govern, and who never come within their operation; whose prosecution, since it can only be achieved by recourse to the services of the spy, the informer, and the "smeller," is persecution, and tends to bring all law into contempt and into public disgust.

That these laws do exist by reason of the judgments of appellate courts (even the Supreme Court of the United States having affirmed their "constitutionality") is not to militate against their injustice or their inconvenience. Those decisions are not as to the expediency, but only as to the technicality, of these statutes; all that those decisions amount to is that as between the individual—the citizen—in their breach, and the State, the State has a right to enact the law under its special (State) Constitution, and that the question of internal traffic—so long as it is not interstate traffic—is not one with which the Federal jurisdiction concerns itself. Legally a State has a right to do what it will within its own boundaries, so long as it does not interfere with the rights of its neighboring States or violate the Federal Constitution. And however absurd its local statutes may be, once legally enacted they must be reviewed at the polls, not in the Federal courts. But there is a question beyond the polls.

Laws are for the greatest good of the greatest number, at least in republics, where the paternal jurisdiction of States is not invited and will not be tolerated. Granting everything that can be said as to the bad effect of liquor itself, every logician will admit that if it can be proved that in a single instance or class of instances the effect of liquor is salutary, that it cures as well as kills (as, for example, in a case of partial drowning or of rattlesnake bite), then to prevent its sale is not only illogical but oppressive. A law can not be judged as benign or harmful accordingly as it is negatively inoffensive. If in a single instance it refuses to save life, then it has ceased to operate benignly and has commenced to operate fatally. No law can exist without a reason for its existence, and when the reason for it fails the law disappears. But when a law operates not only unreasonably but fatally, there should not be much hesitation as to its doom. It is illegal. And this is another case where liquor

laws are dangerous to the community—namely, they might prevent the purchase of enough liquor to save a human life. As it is, there are rural communities, not a thousand miles from the metropolis of New England, where the apothecary will refuse (and in my own experience has refused) to sell the mother of a sick child enough alcohol to light a spirit lamp to warm the little sufferer's sustenance on a summer night at a strange hotel, where no other artificial heat could be procured! This same apothecary could sell Paris green by the pound for the destruction of alleged potato bugs, or morphine, or arsenic, or any other poison on presentation of a scrap of paper beginning with an "℞," and signed by any scrawl which the writer might choose to affix, and call it the signature of a physician. Our apothecary that night was illogical and dangerous to the community, not by instinct or by choice, but by the virtue of the laws of his State—by the laws, as it happened in the case I have in mind, of the noble old Commonwealth of Massachusetts!

But we have not closed the catalogue yet; there is still another, and this by no means a slight, evil, which is caused to the community by prohibitive liquor laws, which might be called, perhaps, the intellectual evil which they work. This is the begetting of the very general horror of wines, spirits, malt liquors, and other drinkables of more or less vinous character, which is allowed to prevail, not only, but is sedulously and perpetually cultivated in certain communities, until very young people are apt to consider themselves as virtuous paragons surrounded by alcoholic demons seeking their destruction, whose fault, and not their own, it will be if they tumble. This idea and sentiment are enormously prevalent, thanks to those industrious people the "temperance" reformers (though they insult one of the cardinal virtues by so calling themselves). I can indeed instance no severer proof of it than to narrate that, having been so fortunate, in the case of some special investigation then on hand, as to unearth the diary kept by an officer of the Revolution during the march of Arnold's and Wooster's commands through the snows of the terrible winter of 1775–'76 to relieve the army in Canada, and the subsequent retreat in rags, hunger, freezing, and wretchedness, I intrusted its copying to a worthy lady, a descendant of the officer who kept the diary. In due time she returned the copy, but wrote me, "I have omitted all references to brandy and eggnog, as not part of our country's history." And yet to me, and I fancy most of us, it was "history"—ay, and the "history of our country" too! How those patriots lived through and managed to survive at all the terrors of that winter, certainly was history; and I for one am thankful that, at least, if there was no food betimes, there were brandy, and an occasional egg-

nog, for those sturdy and starving patriots! But this worthy lady lived in rural New England, and had been taught from her youth of the terrors and misery that lay hidden—not for fools only, but for everybody—in a bottle! And she could not see that God's gifts to men sometimes have come to his perishing creatures in the liquor form. The public inconvenience of this belief is not inconsiderable. Not only are its citizens deprived of the sanitary potency of liquor in emergencies (for I have heard apparently sane persons, in a village not a thousand miles from the city of New York, declare that they would rather die than have their lives saved by a glass of liquor), but the youths are taught, not to be virtuous and sober, and to shun drunkenness, but to persecute liquor sellers and to waste liquor by emptying it into the gutters: that the unfortunate who drinks himself into imbecility, or into becoming a public nuisance, is not a criminal or a lawbreaker, but an example of the wickedness of the hotel keeper—and so not the sinner but the sinned against! Not he to be disciplined or chided, but the innocent liquor is to be cursed, and the liquor dealer to be deprived of his property! It would appear to most of us that to preach a little less about the holy horror of rum, and a little more about the political obligation of the citizen to keep himself from drunkenness—to notify him that the law locks up the wretched drunkard, not because he is not a citizen who can not drink if he please, and not because liquor is a sinful thing, or because his neighbor has no right to invest his capital, if so pleased, in hogsheads of liquor and to retail it by the glass or spoonful, but because he is drunk, and because a drunkard is a nuisance and a threat to the community—would be an experiment worth the trying. Another experiment would be to rely upon such an administration of what laws we have as will encourage temperance by punishing the drunkard, not the liquor which he drinks or the manufacturer or the seller of it, nor yet the community whose misfortune and for whose sins it is that the drunkard is a part of it. We can not reclaim our wayward youth by sending their parents to Sunday school; we can not rid the community of drunkards by refusing to sell liquor to the sober man. But it requires no statute to refuse to sell it to the debauchee. This land of ours is ruled by law. The trend of progress is toward a larger and a more enlightened, not a lesser and more ignorant liberty; and civilizations move not backward. In the calm eye of the law, the owner of pipes of liquor is as much entitled to his own as is the owner of a "temperance" newspaper, as long as he injures not his neighbor. He of the wine pipes must not sell to the habitual drunkard, or to the hereditary victim of alcoholism who works damage in his cups; neither shall he of the printing press libel in words him of the wine pipes, or invite

his fellow-citizens to violence against him or destruction of his worldly goods. For over one and all is the law of the land. Let our youth learn this, and not that others have obligations and stand at their peril, while he alone is free, if he only will sign a pledge and wear a blue ribbon!

In still another way the prohibitive liquor laws have worked, and are still working, hardship to our people. The liquor-drinking habit in large and metropolitan cities is palpably on the decline. Here the ever-increasing complexity of affairs, the immense demand of competition, the necessity of care and vigilance lest one be outrun in the race for success, and the strain of business methods, render it injudicious to drink much wine or liquor; large corporations exact a rigid temperance, often total abstinence, from their officials and employees. Either because edicts of fashion for once have followed the demands of business, or for some other cause it appears to be absolutely no longer fashionable in cities to drink deep or long at table. In the natural course there is reason to believe that this fashion might reach the interior, to prevail there. But, in the towns and cities of the liquor-law-ridden States, the more stringent the ordinances, and the more important and bustling the "smeller," it more and more becomes a point of self-respect, almost of honor, between man and man, to drink much and often, and liquor drinking increases daily. Even lads of tender years, clubbing together, buying a demijohn of what purports to be something of which they have heard their elders speak, and hiding in some cellar or bedroom, experience all the fearful joys of dissipation! In other interior precincts where there never was much liquor drinking, but where the itinerant reformer stands in lieu of lyceum or theater or assembly, the liquor habit will remain about the same, not increasing, but not allowed by the reformers to die out and their occupation be gone. So the maxim of Horace Greeley, that a habitual drunkard is quite as useful a member of society as a temperance reformer, remains unerringly true, not only, but he is positively a retarder of public progress. But once let every liquor law be expunged from the statute-books of our American States and the temperance reformer would disappear, the benign influences of the city would spread to the country, liquor drinking being no longer a matter of courtesy or self-respect, but an indifferent matter of taste, would decrease, as it always has decreased in the civilized communities when let alone and to itself. The horror of liquor would disappear, and only the horror of the drunkard would remain. And the enormous gain would not only be the salvage of the money wasted in pretending to enforce incompetent and disrespected laws, but in behalf of public morality, because with no sumptuary laws to break, there would be no

decent and honorable citizens turned into law-breakers; no personal and paternal statutes to evade, and so no statute evaders.

But until we wipe out all these present restrictive liquor laws we can not hate the drunkard. We must be charitable with him, even cherish as well as pity him; we must even respect him as a man who is upholding the liberty of the subject at the expense of his health; as a sort of public martyr. We must reverse many a popular maxim in his behalf. Instead of "Drunkenness leads to poverty," or "Drunkenness leads to wretchedness," we must read it "Poverty leads to drunkenness," "Wretchedness leads to drunkenness." Instead of worrying lest the horrible inebriate go home and brain his family and smash his furniture, we must cry, "Poor man, he is out of employment," "Poor man, he has an unhappy home, a shrewish wife and bad children, and there was nothing left him but drink," "It is not his fault, it is the fault of that horrid liquor seller." And so on, as if the selling of liquor and not the besotting of one's self with liquor, were the crime; as if the seller and not the drinker were the criminal; as if one who would not drink could be made a drunkard by the selling of liquor; or as if the fruits of the earth expressed or distilled were unholy and abhorred, when in any other form they were God's best gifts to man.

Like most admirable servants, liquor is apt to be a bad master if allowed the upper hand or permitted to get into politics. But there are many persons, not habitual drunkards themselves, who actually believe that malarious and impure water is a circulator of disease, but can be disarmed and rendered safe by the dilution with whisky. The boards of health of cities (New York city, for example), in their printed directions to the public for the prevention of cholera, advise that the water given to infants and very young children in the heated season be diluted with a few drops of whisky. But liquor laws are legislation, not against sick babies, but against the few drops of whisky which might save their little lives, and if the poor parents can not afford to pay a physician for a slip of paper giving the Latin name of whisky, the poor baby must die, or run the risk of death, by drinking malarious water. If there is any such thing as a salutary liquor law, not derived from excise or police jurisdiction, it would be perhaps a statute insuring the purity of liquor; reviving that old English functionary, the "ale-taster," with his care over all drinkables publicly offered for sale. This would be a legitimate and a constitutional law, as providing for the public safety (which is, after all is said, the origin and the summit of all laws). There is no greater charm to the tourist in rural England than the certainty that, no matter how small the village through which he passes, he will find at the inn refreshment and comfort, "eatable

things to eat and drinkable things to drink." Indeed, the ale-taster was once a public benefactor and more important than the mayor, and such was his benign influence that old Harrison, writing in the sixteenth century, declared that the glory of England was her inns. The roads might be rough and full of highwaymen, but at any inn the traveler could take his ease and be sure he would not be poisoned. For four hundred years it has been possible to enter an inn in the smallest and most insignificant rural hamlet in England and get a thimbleful of liquor without peril to one's stomach or to one's self-respect. How is it in those of the United States which prohibit the sale of liquor? As to one's stomach, I merely copy an item from a local newspaper printed in one of those States (suppressing the localities only):

"Some recent cases of poisoning hereabouts have brought out the statement that poor whisky is abundant in this city. It is sold principally in the kitchen dives and in places on the outskirts. Some of the whisky, it is said, has been so poor that wholesale dealers have disclaimed all knowledge of having sold it. Some of the unlicensed dealers have been selling 'whisky,' but where obtained it has been one of the mysteries that are impossible to explain. With the poisoning of the three men on Sunday night and the investigations which have followed, some light has been shed upon the subject."

"It was stated in these columns on Monday that there had been a man about selling a receipt for making whisky. Investigation proves that this is so, but it is impossible to find a liquor dealer who will say he purchased it for five dollars—the price asked. This receipt as near as can be ascertained is as follows: One drachm of oil of vitriol or sulphuric acid, six drachms of spirits of turpentine, three drachms of spirits of juniper, six drachms of oil of almonds, and a quart of elderberry wine; a seductive decoction indeed. These fluids diluted with twenty-four gallons of water will make about twenty-five gallons of whisky, and cost in the neighborhood of one dollar and twenty-five cents, while the same quantity of distilled whisky would cost from forty to seventy-five dollars. Just how much of a business this man has conducted in ——— is not known, but that he has been favored with a fairly good trade is not doubted by the regular wholesale liquor dealers. He has been all through the villages in the ——— and has also been to ———."

So much for the visitor's stomach; now for his self-respect! As a native of the State most strenuous in its policy of prohibiting the sales of liquor, I have been now and again a curious collector of the divers and sundry ruses resorted to in evasion of the statutes by its best citizens, and I am able to note the latest as experienced during the present summer. At a certain watering-place hotel within its paternal jurisdiction, guests who desired wine at dinner, or stimulants at other times, were invited to purchase a keg of an interesting compound known as root beer. A price for this alleged keg was charged to them on their hotel bill, and they were at liberty to visit the wine room, or to order from the waiters any liquors desired, until this price was exhausted,

when another keg of root beer was charged to them, and so on! This, of course, is only one of hundreds of such devices, which are the rule and not the exception in the liquor-prohibiting States. And I beg to ask, what respect a State can expect its citizens to have for its laws, or for themselves, when forced to habitually resort to a deceit which deceives nobody, in order to live as they see fit and as they have an inalienable right to live?

Liquor has always properly been, and always properly will be, a subject of revenue, or, as it is called, excise, and this excise is most conveniently levied in the shape of licenses. Of licenses, high and low, high license is doubtless the best for all concerned, as providing cleaner and more sumptuously appointed drinking places, with that modulation and betterment of manners and of speech to which elegance of surroundings will always conduce. But prohibitive liquor laws should be discontinued, because sixty years of certainly faithful trial have shown them to be failures, dangerous to the public peace, the public health, and the public morals; against public policy as tending to bring all reasonable laws into bad repute, and against absolute right as an interference of the law merchant with the jurisdiction of the criminal law; enacted, as criminal laws are enacted, by those who are not supposed to come under their operation.

Much of what has been said of prohibitory liquor laws in this paper might also be said of the usury laws,* which are of the family of crime-creating statutes, which are always readily evaded and which interfere with the market value of the commodity protected. But there is this difference, that usury laws are demanded by the protected class, while prohibitive liquor laws are not, and never can be.

Admitting freely all that can be said about the horrors which liquor can work, sociologists as well as Samaritans know that no public evil can be dealt with abstractly—dragged up by the roots and exterminated in a single swoop of virtue. Sinful as the liquor industry may be, its absolute and sudden annihilation would throw millions out of employment, and put starvation into the room of competence in countless homes, to remain until, by the slow labor of economists and publicists, capital and labor had readjusted themselves to the new condition. And the literal interpretation of statutes at present upon the statute-books of certain American States would send fathers of families to State prisons to serve out terms of sixty or a hundred years—under cumulative sentences which more than cover the natural lives of men. Fortunately, however, the drinking of liquor does not de-

* In Queen Elizabeth's time the analogy was still more perfect, for the price of liquor was regulated as the price of money now is sought to be by usury laws—by statute.

stroy either the body or the soul. The best evidence obtainable by medical industry intimates that, while, as everybody knows, the temperate outlive all other classes, even the habitually intoxicated man may, and does, outlive the rigid and inexorable total abstainer who refuses to his organism the stimulant which overworked or overstrung human systems sometimes insist upon.*

I do not know what evidence can be subpœnaed as to the loss of souls. But, admitting the occasional loss of a soul, the question might arise as to whether a soul could not be saved at too high a price. Should an entire community like the State of Vermont, or of Maine, or of Kansas, or like Boston, or the city of New York, for example, imperil its sanitary existence to save any one given human soul? Or how large or how small a community should be allotted to peril *per* soul? It requires a strong stomach and a tranquil nervous system to absorb ice water, and dyspeptics and excitable persons are not always deserving of death at the hands of the State.

I know that the easy-going humanitarian answer to this is, that all prohibitive liquor policies carry within themselves the seeds of their own dissolution, since they are only agitated in sparsely settled localities, from which, as populations thicken there, they gently disappear.† But, meantime, if the traffic in liquor is dangerous, these policies are working an enormous harm to the communities where they are tolerated. All history proves that there is no institution or system in the world which it has ever been attempted to stifle by legislation which is not to-day as fixed and immutable as the hills. The efforts of the English Puritans to abolish the theater made theatrical performances parcel of English civilization. The attempts of the middle ages, the Inquisition, and the Index, to destroy the printing press made the printing press a necessity of life everywhere. If liquor is dangerous to the United States of America, philanthropists and patriots should be careful how they pass laws against it!

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* I believe the figures are claimed to be as follows: Out of 4,234 cases of mortality from ordinary causes, the lengths of life were:

Temperate livers	62·13	years.
Careless drinkers	59·67	"
Free drinkers	57·59	"
Habitually intemperate	52·03	"
Total abstainers	51·22	"

According to a recent report of the British Medical Association, in their journal in the year 1891.

† The little town of Westfield, N. J., has two or three active prohibition societies, and I am told that all the churches (except the Roman Catholic and the Episcopal) preach prohibition from their pulpits. Ten years ago, with a population of two thousand, the town cast three hundred prohibition votes; last year, with a population of thirty-seven hundred, as I am informed, it cast just fourteen!

INDUSTRIES OF ANIMALS.*

By FRÉDÉRIC HOUSSAY.

WE find among animals not only hunting and fishing but the art of storing in barns, of domesticating various species, of harvesting and reaping—the rudiments of the chief human industries. Certain animals in order to shelter themselves take advantage of natural caverns in the same way as many races of primitive men. Others, like the fox and the rodents, dig out dwellings in the earth; even to-day there are regions where man does not act otherwise, preparing himself a lodging by excavations in the chalk or the tufa. Woven dwellings, constructed with materials entangled in one another, like the nests of birds, proceed from the same method of manufacture as the woolen stuffs of which nomad tribes make their tents. The termites who construct vast dwellings of clay, the beavers who build huts of wood and of mud, have in this industry reached the same point as man. They do not build so well, no doubt, nor in so complex a fashion as modern architects and engineers, but they work in the same way. All these ingenious artisans operate without organs specially adapted to accomplish the effect which they reach. It is with such genuine industries that we have to deal, for the most part neglecting other productions, more marvelous in certain ways, which are formed by particular organs, or are elaborated within the organism, and are not the result of the intelligent effort of the individual. To this category belong the threads which the spider stretches, and the cocoon with which the caterpillar surrounds himself to shelter his metamorphosis.

Struggles of the Chase.—It is not always sufficient for the hunter to find game and to reach it. If the game is of large size it may be able to hold its own, and the pursuit may end in a violent struggle, in which both skill and cunning are necessary to obtain conquest.

The bird which displays the most remarkable qualities in this struggle which terminates the chase, exhibiting indeed a real fencing match, is the secretary bird (*Gypogeranus reptilivorus*, Fig. 1). He is the more interested in striking without being himself struck, since the fangs with which his prey, the snake, is generally armed might at the first blow give him a mortal wound. In South Africa he pursues every snake, even the most venomous. Warned by instinct of the terrible enemy he has met, the reptile at first seeks safety in flight; the secretary follows him on foot,

* An abstract from the author's book under this title in The Contemporary Science Series. Imported by Messrs. Charles Scribner's Sons, New York

and the ardor of the chase does not prevent him from being constantly on guard. This is because the snake, finding himself nearly overtaken, suddenly turns round, ready to use his defensive weapons. The bird stops, and turns in one of his wings to protect the lower parts of his body. A real duel then begins. The snake throws himself on his enemy, who at each stroke parries with the end of his wing; the fangs are buried in the great feathers which terminate it, and there leave their poison without producing any effect. All this time with the other wing the secretary repeatedly strikes the reptile, who is at last stunned, and

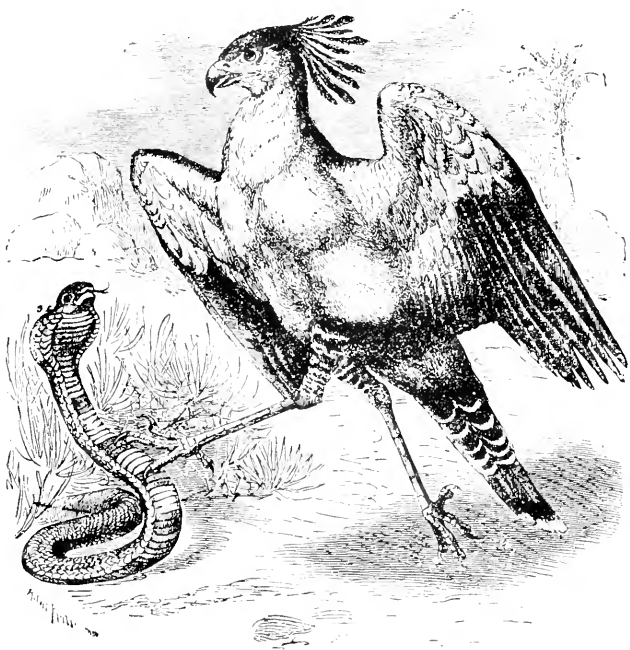

Fig. 1.—Fight between the Secretary Bird and a Snake.

rolls over on the earth. The conqueror rapidly thrusts his beak into his skull, throws his victim into the air, and swallows him.

Hunting with Projectiles.—It has often been repeated that man is the only creature sufficiently intelligent to utilize as weapons exterior objects like a stone or a stick; in a much greater degree, therefore, it was said, was he the only creature capable of striking from afar with a projectile. Nevertheless, creatures so inferior as fish exhibit extreme skill in the art of reaching their prey at a distance. Several act in this way. There is first the *Toxotes iaculator,* which lives in the rivers of India. His principal food is formed by the insects who wander over the leaves of aquatic plants. To wait until they fell into the water would naturally result in but meager fare. To leap at them with one bound is

difficult, not to mention that the noise would cause them to flee. The *Toxotes* knows a better trick than that. He draws in some drops of water, and, contracting his mouth, projects them with so much force and certainty that they rarely fail to reach the chosen aim, and to bring into the water all the insects he desires (Fig. 2). Other animals also squirt various liquids, sometimes in attack, but more especially in defense. The cephalopods, for example, emit their ink, which darkens the water and allows them to flee. Certain insects exude bitter or fetid liquids; but in all these cases, and in others that are similar, the animal finds in his own organism a secretion which happens to be more or less useful to his conservation. The method of the *Toxotes* is different. It is a foreign body which he takes up, and it is an intended victim at which he takes aim and which he strikes; his movements are admirably coordinated to obtain a precise effect.

Fig. 2.—The Toxotes throwing Water at Insects.

Another fish, the *Chelinous* of Java, also acts in this manner. He generally lives in estuaries. It is therefore a brackish water which he takes up and projects by closing his gills and contracting his mouth; he can thus strike a fly at a distance of several feet. Usually he aims sufficiently well to strike it at the first blow, but sometimes he fails. Then he begins again until he has succeeded, which shows that his movements are not those of a machine.

Methods of Utilizing the Captured Game.—Frequently it is not enough for the animal to obtain possession of his prey. Before making his meal it is still necessary to find a method of making use of it, either because the eatable parts are buried in a thick shell which he is unable to break, or because he has captured a creature which rolls itself into a ball and bristles its plumes.

Here are some of the more curious practices followed in such cases.

Sometimes it is a question of carrying off a round fruit which offers no prominence to take hold of. The red-headed woodpecker (*Melanerpes erythrocephalus*) of North America is very greedy with regard to apples, and feeds on them as well as on cherries. It takes him a considerable time to consume an apple, and as he is well aware of the danger he runs by prolonging his stay in an orchard, he wishes to carry away his booty to a safe and sheltered spot. He vigorously plunges his open beak into the apple; the two mandibles enter separately, and the fruit is well fixed; he detaches it and flies away to the chosen retreat.

The combination is complicated, and approaches more nearly the methods employed by man, when the animal makes use of a foreign body, as a tool or as a fulcrum, to achieve his objects. A snake is very embarrassed when he has swallowed an entire egg with the shell; he can not digest it in that condition, and the muscles of his stomach are not strong enough to break it. The snake often finds himself in this condition, and is then accustomed either

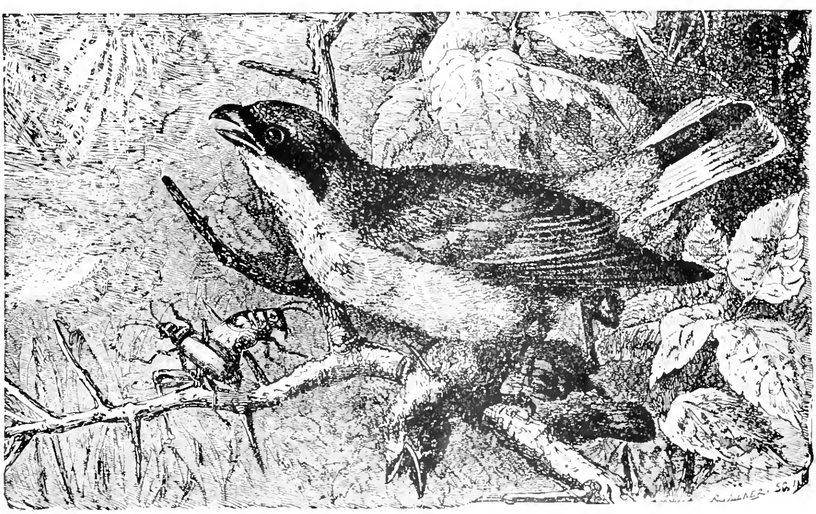

Fig. 3.—The Lanius stocking its Larder.

to strike his body against hard objects or to coil himself around them until he has broken the envelope of the egg he contains.

Neither the beak nor the claws of the shrike or butcher bird (*Lanius excubitor*) are strong enough to enable him to tear his prey easily. When he is not too driven by hunger he installs himself in a comfortable fashion for this carving process, places on a thorn or on a pointed branch the victim he has made, and when it is thus fixed easily devours it in threads.

The *Lanius collurio*, an allied bird, uses this method still more frequently. He even prepares a small larder before feasting. One may thus see on a thorny branch spitted side by side Coleoptera, crickets, grasshoppers, frogs, and even young birds, which he has seized when they were in flight. (Fig. 3.)

Of all these well-attested facts that which perhaps best shows how animals in certain circumstances may take advantage of a foreign body to utilize the product of the chase is the following, the observation of which is due to Parseval-Deschênes. He followed during several hours an ant bearing a heavy burden. On arriving at the foot of a little hillock the animal was unable to mount with his load, and abandoned it—a very extraordinary fact for one who knows the inconceivable tenacity of insects. The abandonment, therefore, left hope of return. The ant at last met one of his companions, who was also carrying a burden. They stopped, took counsel for an instant, bringing their antennæ together, and started for the hillock. The second ant then left his burden, and both together seized a twig and introduced its end beneath the first load which had been abandoned because of its weight. By acting on the free extremity of the twig they were able to use it exactly as a lever, and succeeded almost without trouble in passing their booty on to the other side of the little hillock. It seems to me that these ants who invented the lever are worthy of admiration, and that their ingenuity does not yield to our own.

Animals construct dwellings either to protect themselves from the cold, heat, rain, and other chances of the weather, or to retire to at moments when the search for food does not compel them to be outside and exposed to the attacks of enemies. Some inhabit these refuges permanently; others only remain there during the winter; others, again, who live during the rest of the year in the open air, set up dwellings to bring forth their young, or to lay their eggs and rear the offspring. Whatever the object may be for which these retreats are built, they constitute altogether various manifestations of the same industry, and I will class them, not according to the uses which they are to serve, but according to the amount of art displayed by the architect.

Dwellings formed of Coarsely Entangled Materials.—Diurnal birds of prey are the first animals who practice skillfully the twining of materials. Their nests, which have received the name of eyries, are not yet masterpieces of architecture, and reveal the beginning of the industry which is pushed so far by other birds. Usually situated in wild and inaccessible spots, the young are there in safety when their parents are away on distant expeditions. The abrupt summits of cliffs and the tops of the highest forest trees are the favorite spots chosen by the great

birds of prey. The eyrie generally consists of a mass of dry branches which cross and mutually support one another, constituting a whole which is fairly resistant.

Even these primitive nests are not, however, without more complicated details of interest. Thus Mr. Denis Gale wrote to

FIG. 4.—THE STICKLEBACK AND ITS NEST.

Bendire concerning the golden eagle in America: "Here in Colorado, in the numerous glades running from the valleys into the foothills, high, inaccessible ledges are quite frequently met with which afford the eagles secure sites for their enormous nests. I know of one nest that must contain two wagon-loads of material. It is over seven feet high, and quite six feet wide on its upper sur-

face. In most cases the cliff above overhangs the site. At the end of February or the beginning of March the needful repairs to the nest are attended to, and the universal branch of evergreen is laid upon the nest, seemingly for any purpose save that of utility. This feature has been present in all the nests I have examined myself, or have had examined by others; it would seem to be employed as a badge of occupancy."

It is scarcely necessary to recall the skillful art with which the stickleback, which inhabits all our streams, plaits its nest and remains sentinel near it. (Fig. 4.) This fish has indeed monopolized our admiration, and is considered as the most skillful if not the only aquatic architect. Yet, besides those which I have already mentioned, there is one which equals the stickleback in the skill it displays in constructing a shelter for its spawn. This is the *Gobius niger*, met on our coasts, especially in the estuaries of rivers. The male interlaces and weaves the leaves of algæ, etc., and when he has finished his preparations he goes to seek females, and leads them one by one to lay in the retreat he has built. Then he remains in the neighborhood until the young come out, ready to throw himself furiously with his spines on any imprudent intruders.

Dwellings Woven with Greater Art.—Without doubt the class of birds furnishes the most expert artisans in the industry of the woven dwelling. In our own country we may see them seeking every day to right and left, carrying a morsel of straw, a pinch of moss, a hair from a horse's tail, or a tuft of wool caught in a bush. They intermingle these materials, making the framework of the construction with the coarser pieces, keeping those that are warmer and more delicate for the interior. These nests, attached to a fork in a branch or in a shrub, hidden in the depth of a thicket, are little masterpieces of skill and patience. To describe every form and every method would fill a volume. But I can not pass in silence those which reveal a science sure of itself, and which are not very inferior to what man can do in this line. The Lithuanian titmouse (*Ægithalus pendulinus*), whose works have been well described by Baldamus, lives in the marshes in the midst of reeds and willows in Poland, Galicia, and Hungary. Its nest, which resembles none met in our own country, is always suspended above the water, two or three metres above the surface, fixed to a willow branch.* All individuals do not exhibit the same skill in fabricating their dwelling; some are more careful and clever than others who are less experienced. Some, also, are obliged by circumstances to hasten their work. It frequently happens that magpies spoil, or even altogether destroy with blows

* Baldamus, Beiträge zur Oologie und Nidologie, 1853, pp. 119–145.

of their beaks, one of these pretty nests. The unfortunate couple are obliged to recommence their task, and if this accident happens two or three times to the same household, it can easily be imagined that, discouraged and depressed by the advancing season, they hasten to build a shelter anyhow, only doing what is indispensable, and neglecting perfection.

THE ART OF SEWING AMONG BIRDS.—There are birds which have succeeded in solving a remarkable difficulty. Sewing seems

FIG. 5.—THE TAILOR BIRD AND ITS NEST.

so ingenious an art that it must be reserved for the human species alone. Yet the tailor bird, the *Orthotomus longicauda*, and other species possess the elements of it. They place their nests in a large leaf which they prepare to this end. With their beaks they pierce two rows of holes along the two edges of the leaf; they then pass a stout thread from one side to the other alternately. With this leaf, at first flat, they form a horn in which they weave

their nest with cotton or hair. (Fig. 5.) These labors of weaving and sewing are preceded by the spinning of the thread. The bird makes it itself by twisting in its beak spiders' webs, bits of cotton, and little ends of wool. Sykes found that the threads used for sewing were knotted at the ends. It is impossible not to admire

Fig. 6.—An Edible Birds' Nest and the Swallow that makes it.

animals who have skillfully triumphed over all the obstacles met with in the course of these complicated operations.

Gelatin Nests.—These are made by certain swallows who nest in grottoes or cliffs on the edge of the sea. After having collected from the water a gelatinous substance formed either of the spawn of fish or the eggs of mollusca, they carry this substance on to a perpendicular wall, and apply it to form an arc of a circle. This first deposit being dry, they increase it by sticking on to its edge a new deposit. Gradually the dwelling takes on the appearance of a cup, and receives the workers' eggs. (Fig. 6.) These dwellings are the famous swallows' nests so appreciated by the epicures of the extreme East, which are edible in the same way as, for example, caviare.

Constructions built of Earth—Solitary Masons.—Cer-

tain animals, whose dwelling participates in the nature of a hollow cavern, make additions to it which claim a place among the constructions with which we are now occupied.

The *Anthophora parietina* is in this group: it is a small bee which lives in liberty in our climate. As its name indicates, it prefers to frequent the walls of old buildings, and finds a refuge in the interstices, hollowing out the mortar half disintegrated by time. The entrance to the dwelling is protected by a tube curved toward the bottom, and making an external prominence. (Fig. 7.) The owner comes and goes by this passage, and as it is curved towards the earth the interior is protected against a flow of rain, while at the same time the entry is rendered more difficult for *Melectes* and *Anthrax*. These insects, in fact, watch the departure of the *Anthophora* to endeavor to penetrate into their nests and lay their eggs there. The gallery of entry and exit has been built with grains of sand, the *débris* produced by the insect in working. These grains of sand glued together form, on drying, a very resistant wall.*

The other animals of which I have to speak are genuine masons, who prepare their mortar by tempering moistened earth.

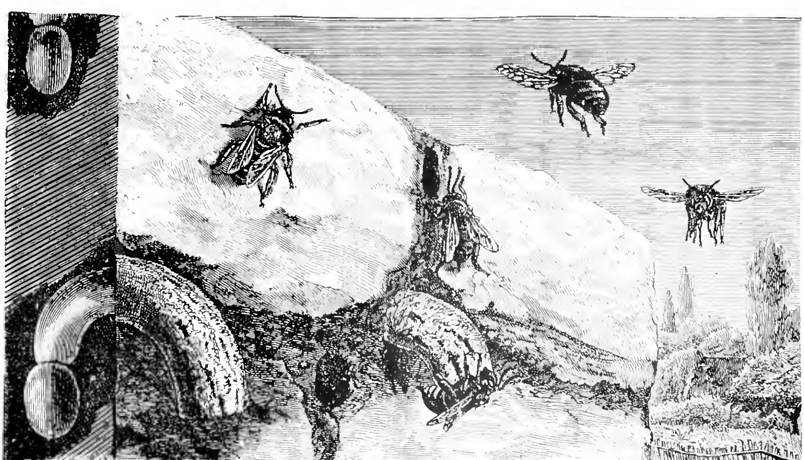

FIG. 7.—HOMES OF MASON BEES.

Every one has seen the swallow in spring working at its nest in the corner of a window. It usually establishes its dwelling in an angle, so that the three existing walls can be utilized, and to have an inclosed space there is need only to add the face. It usually gives to this the form of a quarter of a sphere, and begins it by

* Latreille, "Observations sur l'abeille parietine (*Anthophora parietina*)," Annales du Muséum d'Hist. Nat., t. iii, 1804, p. 257.

applying earth more or less mixed with chopped hay against the walls which are to support the edifice. At the summit of the construction a hole is left for entry and exit. During the whole of its sojourn in our country the swallow uses this dwelling, and even returns to it for many years in succession, as long as its work will support the attacks of time. The faithful return of these birds to their old nest has been many times proved by attaching ribbons to their claws; they have always returned with the distinctive mark.

MASONS WORKING IN ASSOCIATION.—Ants have already furnished us with numerous proofs of their intelligence and their prodigious industry. So remote from man from the anatomical point of view, they are of all animals those whose psychic faculties bring them nearest to him. Sociable like him, they have undergone an evolution parallel to his which has placed them at the head of insects in the same way as he has become superior to all other mammals. The brain in ants, as in man, has undergone a disproportionate development. Like man, they possess a language which enables them to combine their efforts, and there is no human industry in which these insects have not arrived at a high degree of perfection. If in certain parts of the earth human societies are superior to those of ants, in many others the civilization of ants is notably superior. No village of Kaffirs can be compared to a palace of the Termites. The classifications separate these insects (sometimes called "white ants") from the ants, since the latter are Hymenoptera, while the former are ranked among the Neuroptera, but their constructions are almost alike, and may be described together. These small animals, relatively to their size, build on a colossal scale compared to man; even our most exceptional monuments can not be placed beside their ordinary buildings. (Fig. 8.) The domes of triturated and plastered clay which cover their nests may rise to a height of five metres; that is to say, to dimensions equal to one thousand times the length of the worker. The Eiffel Tower, the most elevated monument of which human industry can boast, is only one hundred and eighty-seven times the average height of the worker. It is three hundred metres high, but to equal the Termites' audacity it would have to attain a height of sixteen hundred metres.

The lofty nest, or Termitarium, constitutes a hillock in the form of a cupola. The interior arrangement is very complicated, and at the same time very well adapted to the life of the inhabitants. There are four stories in all, covered by the general exterior walls. The walls of the dome are very thick; at the base they measure from sixty to eighty centimetres. The clay, in drying, attains the hardness of brick, and the whole is very coherent. The sentinels of herds of wild cattle choose these tumuli as ob-

servatories, and do not break them down. The walls of this exterior *enceinte* are hollowed by galleries of two kinds: some horizontal and giving access from outside to all the stories, the others mounting spirally in the thickness of the wall to the summit of the dome. When the colony is in full activity, after the construction is completed, these little passages have no further use. They served for the passage of the masons when building

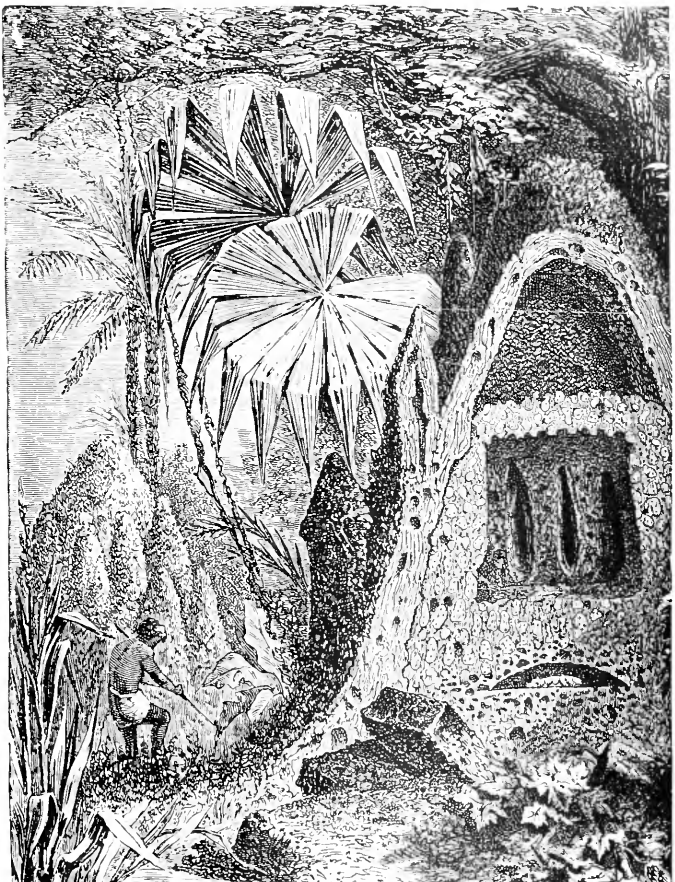

Fig. 8.—Section of a Palace of the Termites.

the cupola, and they could be utilized again if a breach should be made in the wall. At the lower part these galleries in the wall are very wide, and they sink into the earth beneath the palace to a depth of more than 1·50 metre.

These subterranean passages are the catacombs of the Termites, and have a very close analogy with those of old and populous human cities. Their origin is similar; they are ancient quarries. The insects hollowed them in obtaining the necessary

clay for their labors. Later, when the rains come, they serve as drains to carry off the water which might threaten to invade the dwelling.

Comparative anatomy has long since removed the barriers, once thought impassable, raised by human pride between man and the other animals. Our bodies do not differ from theirs; and, moreover, such glimpses as we are able to obtain allow us to conclude that their psychic faculties are of the same nature as our own. Man in his evolution introduces no new factor.

The industries in which the talents of animals are exercised demonstrate that, under the influence of the same environment, animals have reacted in the same manner as man, and have formed the same combinations to protect themselves from cold or heat, to defend themselves against the attacks of enemies, and to insure sufficient provision of food during those hard seasons of the year when the earth does not yield in abundance.

It must only be added, to avoid falling into exaggeration, that man excels in all the arts, of which only scattered rudiments are found among the other animals; and we may safeguard our pride by affirming that we need not fear comparison. If our intelligence is not essentially different from that of animals, we have the satisfaction of knowing that it is much superior to theirs.

THE ORIGIN OF RIGHT-HANDEDNESS.

By J. MARK BALDWIN,
PROFESSOR OF EXPERIMENTAL PSYCHOLOGY IN PRINCETON UNIVERSITY.

THE question "Why are we right or left handed?" has exercised the speculative ingenuity of many men. It has come to the front anew in recent years in view of the advances made in the general physiology of the nervous system; and certainly we are now in a better position to set the problem intelligently and to hope for its solution. Hitherto the actual conditions of the rise of "dextrality"—as the general fact of uneven-handedness may be called—in young children have not been closely observed. It was to gain light, therefore, upon the facts themselves that the experiments described in the following pages were carried out.

My child H—— was placed in a comfortable sitting posture, the arms left bare and free in their movement, and allowed to reach for objects placed before her in positions exactly determined and recorded by a simple arrangement of sliding rods. The experiments took place at the same hour daily for a period extending from her fourth to her tenth month. These experiments were

planned with very great care and with especial view to the testing of several hypotheses which, although superficial to those who have studied physiology, yet constantly recur in publications on this subject.* Among these theories certain may be mentioned which my experimental arrangements were aimed to test. It has frequently been held that a child's right-handedness arises from the nurse's or mother's constant method of carrying it; the child's hand which is left free being more exercised, and so becoming stronger. This theory is ambiguous as regards both mother and child. The mother, if right-handed, would carry the child on the left arm, in order to work with the right arm. This I find an invariable tendency with myself and with nurses and mothers whom I have observed. But this would leave the child's left arm free, and a right-handed mother would be found with a left-handed child. Again, if the mother or nurse is left-handed, the child would tend to be right-handed. Or if, as is the case in civilized countries, nurses replace the mothers, it would be necessary that most of the nurses be left-handed in order to make most of the children right-handed. Neither of these positions is true. Further, the child, as a matter of fact, holds on with both hands, however it is itself held. Another theory maintains that the development of right-handedness is due to differences in weight of the two lateral halves of the body; this tends to bring more strain on one side than the other, and so to give more exercise to that side. This evidently assumes that children are not right or left handed before they learn to stand. This my results given below show to be false. Again, we are told that infants get right-handed by being placed on one side too much for sleep: this can be shown to have little force also, when the precaution is taken to place the child alternately on its right and left sides for its sleeping periods.

In the case of the child H—— certain precautions were carefully enforced. She was never carried about in arms at all—never walked with when crying or sleepless (a ruinous and needless habit to cultivate in an infant); she was frequently turned over in her sleep; she was not allowed to balance herself on her feet until a later period than that covered by the experiments. Thus the conditions of the rise of the new right-handed era were made as simple and uniform as possible.

The experiments included, besides reaching for colors, a great many of reaching for other objects, at longer and shorter distances, and in unsymmetrical directions. The following table (I)

* Cf. Vierordt's remarks, Physiologie des Kindesalters, pp. 428, 429. For a detailed statement of theories on this topic, see chapter x of the very learned monograph on The Right Hand: Left-handedness, by my late lamented colleague and friend Sir Daniel Wilson.

gives some details of the results of the experiments in which simple objects were used, extending over a period of four months (fifth to ninth in her life). The number of experiments at each sitting varied from ten to forty; the position of the child being reversed after half of each series.

TABLE I.

Date.	No. of series.	No. of experiments.	Right hand.	Left hand.	Both hands.
1890. February 10th to March 15th...	30	744	173	166	405
March 14th to April 14th......	25	623	134	141	348
April 14th to May 14th........	25	546	213	130	203
May 14th to June 19th........	16	274	57	131	86
Total.....................	96	2,187	577	568	1,042

It is evident from Table I that no trace of preference for either hand is discernible during this period; indeed, the neutrality is as complete as if it had been arranged beforehand, or had followed the throwing of dice.

I then conceived the idea that possibly a severer distance test might affect the result and show a marked preferential response by one hand over the other. I accordingly continued to use a neutral stimulus, but placed it from twelve to fifteen inches away from the child. This resulted in very hard straining on her part, with all the signs of physical effort (explosive breathing, sounds resulting from the setting of the larynx, rush of blood to the head, seen in flushing of the face, etc.). Table II gives the results; the number in each series was very small—i. e., one to twelve (in one instance only):

TABLE II.

Date.	No. of series.	No. of trials.	Right hand.	Left hand.	Both hands.
1890. May 26th to June 10th.........	32	80	74	5	1

The same cases, distributed according to distance, give us Table III.

TABLE III.

	12 inches.	13 inches.	14 inches.	15 inches.
Right hand..........................	29	10	33	2
Left hand...........................	5	..	..	..
Both hands..........................	1	..	..	..

A comparison of II and III with I shows a remarkable difference—i. e., during the month ending June 15th, the child showed

no preference for either hand in reaching straight before her within easy reaching distance (ten inches); but she was right-handed to a marked degree during the same period as regards movements which required effort or strain, such as grasping for objects twelve to fifteen inches distant. The left hand was used in only five cases as against seventy-four cases of the use of the right hand; and further, all these five cases were twelve-inch distances, the left hand being used absolutely not at all in the forty-five cases at longer distances.

In order to test this point further, I varied the point of exposure of the stimulus to the right or left, aiming thus to attract the hand on one side or the other, and thus to determine whether the growth of such a preference was limited to experiences of convenience in reaching to adjacent local objects, etc. The result appears in Table IV:

TABLE IV.

	12 inches.	13 inches.	14 inches.	15 inches.	Hand used.	
					Right.	Left.
Deviations from median line—						
2 to 6 inches to left	10 cases	15 cases	4 cases	....	35	....
2 to 6 inches to right	2 "	3 "	1 "	....		
Same conditions with color stimulus	....	....	....	....	15	2

This table shows that deviation to the left in front of the body only called out the right hand to greater exertion, while the left hand fell into still greater disuse. This seems to show that dextrality is not derived from the experience of the individual in using either hand predominantly for reaching within the readiest range of that hand.

Proceeding upon the clew thus obtained—i. e., that a stronger effort brought a preferential hand reaction—a clew which seems to suggest that the hand preference is a function of the relative strength of the influence of the eye stimulus, I introduced hand observations into a series of experiments on the same child's perception of the different colors which I was making at that time, thinking that the color stimulus which represented the strongest inducement to the child to reach, might have the same effect in determining the use of the right hand as the increased distance in the experiments already described. This inference is proved to be correct by the results given in Table V:

TABLE V.

Color stimulus, 10 to 15 inches	Hand	Right.	Left.	Both.	May 23d to June 19th.
	Number of cases	86	2	..	

It should be added that in all cases in which both hands are said to have been used, each hand was called out with evident in-

dependence of the other, both about the same time, and both carried energetically to the goal. In many other cases in which either right or left hand is given in the tables, the other hand also moves, but in a subordinate and aimless way. There was a very marked difference between the use of both hands in some cases, and of one hand followed by, or accompanied by, the other in other cases. It was very rare that the second hand did not thus follow or accompany the first; and this was extremely marked in the violent reaching for which the right hand was mainly used. This hand was almost invariably accompanied by an objectless and fruitless symmetrical movement of the other.

The results of the entire series of experiments on the use of the hands may be stated as follows, mainly in the words in which I reported them summarily some time ago: *

1. I found no trace of preference for either hand as long as there were no violent muscular exertions made (based on 2,187 systematic experiments in cases of free movement of hands near the body: i. e., right hand, 577 cases; left hand, 568 cases; a difference of nine cases; both hands, 1,042 cases; the difference of nine cases being too slight to have meaning).

2. Under the same conditions the tendency to use both hands together was about double the tendency to use either (seen from the number of cases of the use of both hands in the statistics given above), the period covered being from the child's sixth to her tenth month inclusive.

3. A distinct preference for the right hand in violent efforts in reaching became noticeable in the seventh and eighth months. Experiments during the eighth month on this cue gave, in 80 cases, right hand, 74 cases; left hand, 5 cases; both hands, 1 case. This was true in two very distinct classes of cases: first, reaching for neutral objects (newspaper, etc.) at more than the reaching distance; and, second, reaching for bright colors at any distance. Under the stimulus of bright colors, from 86 cases, 84 were right-hand cases and 2 left-hand. Right-handedness had accordingly developed under pressure of muscular effort in the sixth and seventh months.

4. Up to this time the child had not learned to stand or to creep; hence the development of one hand more than the other is not due to differences in weight between the two longitudinal

* Science, xvi, October 31, 1890; discussed by James, Science, November 8, 1890, by Dr. J. T. O'Connor, ibid., xvi, 1890, p. 331, and by myself, ibid., xvi, November 28, 1890. The report is quoted in full in Nature, November 13, 1890, and in part in the Illustrated London News, January 17, 1891. See also Ebbinhaus's Zeitsch. für Psychologie, ii, 1891, p. 239; Wilson, The Right Hand: Left-handedness, pp. 128–131; Revue Scientifique, 1891, ii, p. 493; discussed by Mazel, Revue Scientifique, 1892, i, p. 113. Both writers in the last-named journal cite these experiments wrongly as Wilson's.

halves of the body. As she had not learned to speak or to utter articulate sounds with much distinctness, we may say also that right or left handedness may develop while the motor speech center is not yet functioning.

5. In most cases involving the marked use of one hand in preference to the other, the second or backward hand followed slowly upon the lead of the first, in a way clearly showing symmetrical innovation of accompanying movements by the second hand. This confirms the inference as to such movements drawn from the phenomena of mirror-writing, etc., by Fechner and E. H. Weber.

Some interesting points arise in connection with the interpretation of these facts. If it be true that the order of rise of mental and physiological functions is constant, then for this question the results obtained in the case of one child, if accurate, would hold for others apart from any absolute time determination. We would expect, therefore, that these results would be confirmed by experiments on other children, and this is the only way their correctness can be tested.*

If, when tested, they should be found correct, they would be sufficient answer to several of the theories of right-handedness heretofore urged. The phenomenon can not be due to differences in balance of the two sides of the body, for it arises before the body begins to stand erect. It can not be due to experience in the use of either hand, since it arises when there is no such difference of experience, and since the hand preferred is used, as a matter of fact, for purposes for which in experience the other would be altogether more convenient.† The rise of the phenomenon must be sought, therefore, in more deep-going facts of physiology than such theories supply.

If, on the other hand, heredity be brought to the aid of these "experience" theories, it is possible to claim that, as structure is due to function, experience of function must have been first; and only thus could the modification in structure which is now sufficient to produce right-handedness in individual cases have been brought about. On the other hand, if we go lower in the animal scale than man, analogies for the kinds of experience which are

* Vierordt says concerning such experiments: "Adequate observations are wanting on the grasping movements of the infant's left and right arm—a kind of observations which would be of the first importance for this inquiry" (Physiologie des Kindesalters, p. 428); and Wilson: "Only a prolonged series of observations, such as those by Prof. Baldwin already noted, made at the first stage of life, and based on the voluntary and the unprompted actions of the child, can supply the needful data" (Left-handedness, p. 209).

† An additional point, which I think is true, is that a right-handed child learns to shake hands properly—using the more inconvenient hand across his body—more easily than the left-handed child.

urged as reasons for right-handedness are not present; animals do not carry their young, nor pat them to sleep, nor do animals shake hands! It must therefore be shown that animals are right or left handed, or that they differ in some marked respect in regard to function, in their nervous make-up, from man. Admitting the need of meeting these requirements; admitting again that we have little evidence that animals are dextral in their functions; admitting also the known results as to the control of the two halves of the muscular system by the opposite brain hemispheres respectively; admitting further that the motor speech function is performed by the hemisphere which controls the stronger side of the body, and is adjacent to the motor arm center in that hemisphere; and admitting, finally, that the speech function is one in which the animals have little share—all these admissions lead us at once to the view that there is a fundamental connection between the rise of speech and the rise of right-handedness.*

Looking broadly at the methods of nervous and muscular development, and accepting all the results of neurology we are able to gather, we may say that in the differentiation of functions in the animal series certain principles may be recognized: 1. The deep-seated vital functions represent least nervous differentiation, as is seen in the simple organs known as the lower nervous centers. 2. New unsymmetrical functions give a differential or twofold organic development, the great instance of which is found in the cerebral hemispheres. 3. New symmetrical or unilateral functions find their counterpart each in one of three kinds of nervous adaptation: (*a*) co-ordination of the hemispheres in a single function—i. e., functions which are crippled if either hemisphere is damaged; (*b*) co-ordination of particular functions in each hemisphere—i. e., functions which are not crippled unless both hemispheres are damaged; and (*c*) co-ordination of particular functions in one hemisphere only—i. e., functions which are crippled if one selected hemisphere is damaged. All these kinds of co-ordination exist.

It is easy to see that both speech and right-handed function belong under the last head of the last class—co-ordinations of particular functions in one hemisphere only—and that they belong in the same hemisphere. Why is this? What have they in common?

A very essential kind of hand movements are the so-called "expressive" movements, meaning those which serve to convey a meaning, or express a state of consciousness. Of course, speech is

* This much has been before surmised (see Mazel, Revue Scientifique, 1892, i, p. 113). He makes no attempt, however, to account for the association, except by calling both functions expressive.

par excellence the function of expression. It is further only a part of the position upon which the psychological theory of expression is based, that all movements are in so far expressive, and that details of expression and its relative fullness are matters of co-ordination. Now, this co-ordination has attained its ripest and most complex form, apart from speech, in movements of the hand. Upon this view it is easy to hold that right-handedness is a form of expressive differentiation of movement, and that it preceded speech, which is a further and more complex form of differentiation and adaptation.

The neurological basis upon which this hypothesis rests is adequate, and affords a presumption as to the psychological development as well. The facts I have now given, for the first time, go some way to support the view: 1. Right-handedness arose before speech in the child H——. 2. Imitation by the hand of movements seen arise before articulate imitations of sounds heard;* this in spite of the fact that hearing, in its development in the child, becomes perfect before sight. 3. Characteristic differences in children in respect to their general mobility of arm and hand, manual skill, and quickness of manipulation, extend also to speech. As compared with my other child, E——, the first-born, H——, is remarkably agile and motile generally in her temperament; and her speech development was relatively much earlier and more rapid.

It is further interesting to note that musical ability is associated with speech ability—a connection which would be expected when one takes due account of the expressive character and function of music. As far as theories of the rise of musical expression have gone, they unite in finding its beginnings in the rudimentary emotional expressions of the animals. The singing of birds is undoubtedly connected with their mating instincts. Pathological cases also show a marked connection between musical execution and speech, to the extent that, while musical defect almost invariably involves speech defects, the reverse is much less generally true—a fact which confirms the view that music is an earlier form, but still a form, of expressive reaction.

Late observations also show, as far as they are sufficient, that the center for music expression is also located normally in the left hemisphere for right-handed persons. Oppenheim reports a case † of total aphasia with total amusia (lack of musical ability from disease) in which the recovery of speech brought with it musical recovery also. Furthermore, another case of Oppenheim's shows motor aphasia with motor amusia only—i. e., the

* It is interesting that of both hand and speech movements the latest to be lost in disease are those involved in the so-called "mimicry" of movement and in imitative speech.

† Charité Annalen, xiii, 1888, p. 286.

patient could still understand tunes, and, further, could imagine tunes "in his head" (what the French call *intérieur*), while he could not sing them. This shows a close connection in locality between motor speech and motor music function, while a slight separateness of the two centers in locality in the left hemisphere, explains cases of motor aphasia in which musical execution is preserved. Further, Frankl-Hochwart declares that no cases are recorded of amusia from lesion in the right hemisphere,* and Starr says (in a private letter) of a patient of his: † "My patient is right-handed, and music does follow speech in being unilaterally located; . . . it is well proved that the musical faculty is one-sided in location." Despite these positive opinions, I think more critical cases with autopsy are necessary to make the position quite secure.

All this means simply that the general cause to which is due the fact of right-handedness is also the cause, through further differentiation and emphasis in the same local seat, of the development of musical ability and of speech. It now remains to ask: What was or is this cause, and when in the race-history series did it begin to operate? There are only two hypotheses of any force—either "experience" or "spontaneous variation" at some stage in biological development.

It is extremely improbable that dextrality should have arisen among the quadrupeds (or amanous bipeds), for experience was lacking of unilateral stimulation, and a spontaneous variation of this kind would have produced such inconvenience of locomotion and ultimately such asymmetry of form that it would have been weeded out. ‡ As an extreme example, fancy a bird which is dextral in its flight.#

As soon as we come to bipeds with hands, however, these reasons do not hold. Their locomotion does not depend on manual symmetry, and any dextrality, however slight, would be of direct advantage in climbing, fighting, breaking sticks, and pulling fruit; since a disproportionate growth of one side would give that side greater strength than either side would possess in animals of symmetrical development in the same environment. A very strong one-armed man can keep at bay a weaker man with two arms, or destroy him, and this is emphasized in animals, where brute force is the only resource. It is difficult to find, however, in the habits of simians any ground for believing that there has

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* This means that all cases noted have been right-handed. Deutsche Zeitsch. für Nervenheilkunde, 1891, i, p. 295 and foot-note.

† Referred to in The Psychological Review, January, 1894, p. 92.

‡ For this reason the human leg, as Brown-Séquard says, is not as right-sided as the arm.

The only evidence I know of such a thing is that a cat swims in a circle; but then dogs and horses do not.

been a form of unilateral stimulation which would act to effect a structural change in one hemisphere over and above the other. But, apart from this, there is every reason to expect, quite independently of function, that two organs of such comparative separateness and independence of function would not remain exactly balanced in function; in short, spontaneous variations giving advantageous dextrality would inevitably arise and persist as soon as the habits of life were not such that more important functions, such as locomotion, tended to suppress them and restore bilateral equilibrium.* There are, as far as I know, very few published observations of fact in regard to simian or animal dextrality.†

It is likely, therefore, that right-handedness in the child is due to differences in the two half-brains, reached at an early stage in life, that the promise of it is inherited, and that the influences of infancy have little effect upon it. Yet, of course, regular habits of disuse or of the cultivation of the other hand may, as the child grows up, diminish or destroy the disparity between the two. And this inherited brain-onesidedness also accounts for the association of right-handedness and speech—the speech function being a further development of the same unilateral potency for movement found first in right or left handedness.

The Marquis of Salisbury has been nominated as president of the next meeting of the British Association, which will be held in Oxford, August 8th. In proposing him, Sir F. Bramwell mentioned, as among the claims of the marquis, that he had been Chancellor of the University of Oxford since 1880, that he would therefore represent both hosts and guests, that he was a distinguished statesman, a courteous gentleman, a member of the Council of the Royal Society, and a true man of science. Ipswich has been designated as the place for the meeting of 1895.

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* It is on this point that I differ from Wilson, who claims that while some are naturally right or left handed, most people owe the peculiarity to education; the evidence, apart from my experiments, is well put by Mazel, *loc. cit.*

† I know only the assertion of Vierordt that parrots grasp and hold food with the left claw, that lions strike with the left paw, and his quotation from Livingstone—i. e., "All animals are left-handed" (Vierordt, *loc. cit.*, p. 428). Dr. W. Ogle reports observations on parrots and monkeys in Trans. Royal Med. and Chirur. Society, 1871. Dr. Ogle informs me in a private letter that the chimpanzee which recently died in the Zoölogical Garden in London was discovered by him to be left-handed. I have addressed a circular letter to some of the officials in zoölogical institutions here and abroad, and hope to gather some facts in this way. It is evident that on this theory of spontaneous variation any change which produced a permanent organic superiority of one hemisphere would be sufficient, and the view that the difference in the hemispheres is due to a better blood supply to the left hemisphere might thus have its justification. As a matter of fact, the arterial arrangements do seem to indicate a more direct blood supply to the left hemisphere (cf. the note of Dr. J. T. O'Connor, apropos of my experiments, in Science, xvi, 1890, p. 331). It is an interesting inquiry whether this arterial arrangement is reversed in left-handed persons. Wilson cites two cases in which there was no such correspondence (*loc. cit.*, p. 179).

FOSSIL MAN.*

By JOHN G. ROTHERMEL.

WITHIN a comparatively short time our knowledge of man's existence upon the earth has been greatly increased. By the aid of monuments, language, man's handicraft in stone, brass, bronze, and iron in constructing implements of warfare and husbandry, the anthropologist has been able to classify prehistoric man into ages—namely, the chipped stone or palæolithic, the polished stone or neolithic, the brass, the bronze, and the iron ages.

The purpose of this paper is to deal with the evidence of the earliest of these. The records are to be found in Nature's infallible history of the world's development printed on pages of rock in fossil type. In order that those present not conversant with geology may more clearly understand what is to follow, it will perhaps be well to briefly explain the order and arrangement of these pages of rock.

To carry out the simile, we might say that this great history is written in three volumes—the first and earliest called Palæozoic or Primary; the second, Mesozoic or Secondary; and the third, Kainozoic or Tertiary. The first volume, or Palæozoic, is divided into three books, each book treating of the flora and fauna which existed at the time of which it speaks. The first book is called Silurian, and treats of that part of the age when invertebrates predominated; the second, Devonian, and treats of that part of the age when fishes predominated; the third, Carboniferous, and treats of that part of the age when coal plants predominated. The second volume, or Mesozoic, is a record of the times when reptiles predominated. The third volume, Kainozoic, is a record of the times when mammals predominated.

It must be understood that there is no clear-cut line of demarcation separating the life of these ages, some of the forms of the earliest existing to-day, others having become extinct, the orders of life named with each age being simply the predominating life of the period. All these periods are divided into many minor subdivisions. Man being a mammal, we are, however, interested only in the subdivisions of the Kainozoic or Tertiary. This period, beginning with the earliest, is divided into Eocene, Oligocene, Miocene, Pliocene, and Post-Pliocene or Post-Tertiary, also called Quaternary. For the purposes of this subject we are interested mainly in the Post-Pliocene or Quaternary, which some

* A lecture delivered May 12, 1893, in the Popular Course before the Academy of Natural Sciences, Philadelphia.

geologists subdivide, beginning with the earliest, into Pleistocene, Glacial, and Recent.

The most important features of the Post-Pliocene or Quaternary period are: First, the advent of man and contemporaneous flora and fauna. Second, the great Glacial period—the period when the glaciers extended over the greater part of Europe and North America, as attested by the drift formation with its immense bowlders torn from mountain sides and carried a hundred miles or more; glacial scratches — grooves made by the rocks carried by the glaciers on the surfaces upon which they moved; terminal and lateral moraines, heaps of rocks left by the melting ice marking the limits of the glaciers. This Glacial epoch separates the Post-Pliocene into the three divisions mentioned before, which may be called Preglacial, Glacial, and Post-glacial, instead of Pleistocene, Glacial, and Recent.

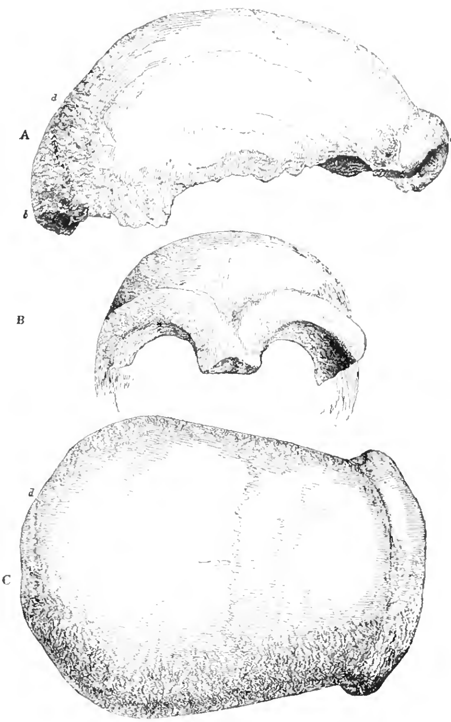


Fig. 1.—The Skull from the Neanderthal Cavern. A, side; B, front; and C, top view. The outlines from camera lucida drawings, one half the natural size, by Mr Busk; the details from the cast and from Dr. Fuhlrott's photographs. *a*, glabella; *b*, occipital protuberance; *d*, lambdoidal suture. (From Huxley's Man's Place in Nature.)

It will, perhaps, be of interest to briefly indicate some of the hypotheses that have been advanced to account for this Glacial epoch. In the first place, any hypothesis, in order to satisfy the necessities of the proposition, must include two seemingly opposed conditions and explain their interaction. To form a glacier, both heat and cold are necessary; to form an ice mass, there must be something to be frozen; therefore there must exist sufficient heat to vaporize water, charging the atmosphere with aqueous vapor, which when carried to higher altitudes or subjected to cold is condensed and precipitated in the form of snow, the accumulation of which forms the glaciers. Hence, in a glacial region, if the mean temperature is comparatively high, the snowfall must be great, otherwise the heat would melt the snow faster

than or as fast as it accumulated; if the mean temperature is low, the snowfall may be light and yet the glaciers accumulate, as the heat would be insufficient to melt that which did fall; but if the mean temperature is so high as to prevent the accumulation of snow, or so low as to prevent the formation of aqueous vapor, there can be no glaciers formed, the last conclusion being subject to the qualification that a vapor-laden atmosphere may be carried by prevailing winds from a warm climate to a cold one, and the vapor there condensed and precipitated.

One hypothesis is that the whole solar system passes at times through stretches of space of different temperatures, and that the Glacial period coincides with a time when the solar system was passing through a low-temperature area; another is that the heat of the sun varies, such variations being the result mainly of contact with meteorites, as the impact of bodies generates heat, the idea being that the Glacial epoch coincides with a time when

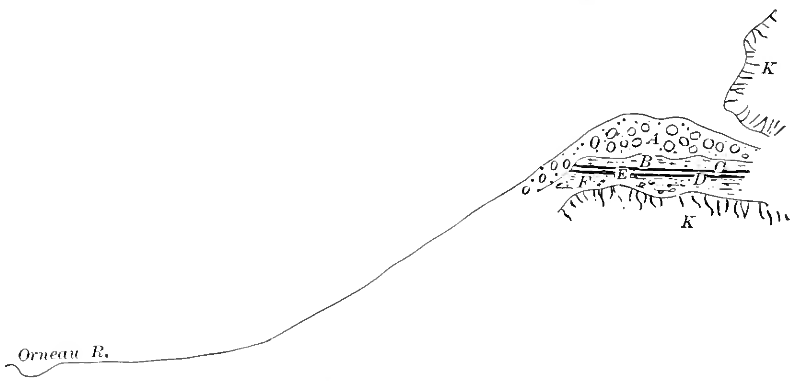


Fig. 2.—Section through Cave.

few meteorites were colliding with the sun, the heat emanating therefrom being therefore decreased. These two hypotheses agree in one particular—they can neither be proved nor disproved, consequently their only value is speculative.

Again, it is supposed that the earth's axis has shifted—that during the Glacial period the north pole was in Greenland. This seems to be negatived by the slight observed shifting of the pole, and the fact that Tertiary fossil flora, immediately preceding the Glacial period, of both Greenland and the present arctic regions, indicate a temperate climate.

Adhémar the astronomer advanced the hypothesis, also advocated by the late Dr. James Croll and Prof. James Geikie, that, as the earth's orbit is elliptical and as the sun is not central to this orbit but some three million miles nearer one end than the other, this fact in connection with the precession of the equinoxes may explain the Glacial epoch; it being held that during that

period when winter in the Northern hemisphere coincides with the earth's position in its orbit farthest from the sun, the mean temperature of the Northern hemisphere will be considerably lower than when the reverse conditions prevail—that is, when winter in the north coincides with the earth's position in its orbit nearest to the sun, as at present. Moreover, this change of position of the earth in its orbit would likely result in a change in direction of the trade winds, the air currents being mainly caused by the expansive action of heat creating a vacuum into which the air rushes from colder areas; therefore, as the Southern hemisphere would become the warmer, the prevailing winds would be southward, thus changing the direction of ocean currents, like the Gulf Stream, to the southward, this being a secondary cause resulting from the first and further intensifying the cold.

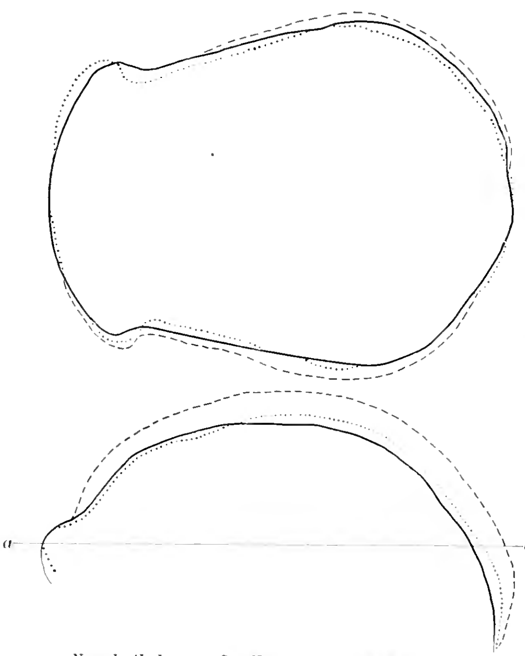
This hypothesis is supported by the fact that at present winter in the Southern hemisphere coincides with the earth's position in its orbit farthest from the sun, and the ice around the south pole extends much farther toward the equator than that around the north pole, the antarctic ice extending as far as the sixty-seventh degree of latitude. The antarctic summers are also said to be more humid, cold, and chilly than the arctic summers.

But the earth's orbit is not always the same; there have been periods when the orbit described resulted in a considerably greater difference than three million miles, and it is thought that if this ordinary eccentricity of the orbit is insufficient to account for the Glacial epoch, the periods of greater eccentricity would.

This hypothesis seems to explain rather overmuch, for if true, it accounts not only for the Glacial period, but for many glacial periods in the past, for, other conditions remaining the same, there would result a Glacial period for every period in the past that the earth held the proper relative position in its orbit; and if true, there should be geological evidence to sustain it, which there does not appear to be, for such evidence of earlier glaciers as the rocks of past geological ages exhibit would seem to indicate local glaciers, not any widespread glacial action; but it would be rash to maintain that the other conditions remained the same; geology can not be said to show that they did.

Still another hypothesis is that the Isthmus of Panama was in glacial times submerged, thus allowing the Gulf Stream to flow into the Pacific Ocean and thence north; also that the northern coast of British America was more elevated than at present. There is geological evidence to sustain both these propositions, but not conclusively. It is obvious that under these conditions the eastern part of the northern coast would be much colder, being more elevated and having lost the heat emanating from the Gulf Stream, while the western part would be warmer, having

gained the heat of the Gulf Stream; thus for the eastern part we have cold accounted for and for the western part heat—but the glacial condition extended the whole length; therefore, while it seems possible that glaciers might form on the western part by reason of the snowfall being great, the case is different for the eastern part, which seems to have been entirely deprived of its vapor-making element, heat, for even under existing conditions the mean temperature of Greenland and Labrador is low and the snowfall light as compared with Alaska. The answer is made to this that western winds carried the moisture-laden atmosphere from the west coast to the east, but these winds would have to cross the Sierra Nevada and Rocky Mountains, forcing them to higher altitudes, resulting in the condensation and precipitation of their vapor upon the mountains. This difficulty is overcome by having recourse to the immense lava outflows, covering thousands of square miles west of the Rocky Mountains, which are supposed to have taken place about the Glacial period; this molten mass is supposed to have generated so much heat as to modify the customary effect of mountain ranges and get the vapor-laden atmosphere to the needed point and thus satisfy the hypothesis, but it offers no explanation of the Glacial period in Europe.



——— *Neanderthal* .... *Spy No. 1* - - - - - - *Spy No. 2*

FIG. 3.—SUPERIMPOSED OUTLINE DRAWINGS OF SKULLS.

Many leading geologists favor this view, while others think the truth will be found in a combination of the last two hypotheses, both being in some measure contributory to the result.

Fossil man has been found in certain countries associated with the remains of certain animals, among which are the mammoth, woolly rhinoceros, cave bear, fossil horse, Irish elk, cave hyena, cave tiger, reindeer, elk, musk ox, aurochs, hippopotamus, lion, and others. These animals are either now extinct or are, for cli-

matal and other reasons, no longer inhabitants of the countries where fossil man has been found; hence, as related to those countries, they are all extinct.

It will be noticed that, of these animals as we now know them, the lion, tiger, hyena, and hippopotamus are tropical, or indigenous to warm climates. The reindeer and musk ox are arctic, and no doubt the extinct mammoth and woolly rhinoceros were arctic also. During glacial times these arctic and tropical animals appear to have occupied the same territory contemporaneously. This fact seems more particularly conspicuous with the lion, tiger, hyena, hippopotamus, mammoth, and woolly rhinoceros; the reindeer and musk ox appearing, at least abundantly, somewhat later. This fact has given rise to considerable difference of opinion. It has been argued that the tropical forms are

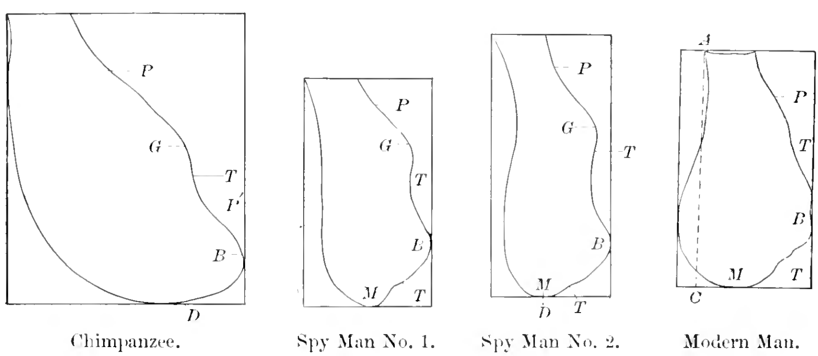


FIG. 4.—OUTLINE DRAWINGS OF THE SYMPHYSES. (From Fraipont and Lohest.)

post-glacial, and that subsequent to the Glacial period the glaciated area passed through a period of tropical conditions.

This argument seems clearly untenable from any point of view, as there is no evidence of a tropical climate intervening between the Glacial epoch and the present temperate climate. All the evidence shows a gradual amelioration of climate until the present conditions are reached. Again, as the mammoth and woolly rhinoceros, supposed to be arctic forms, appear associated with the tropical forms in the same deposit, side by side, they would have to be considered tropical. For this there is reason, as their present representatives, the elephant and rhinoceros, are tropical.

But the facts are these: the reindeer and musk ox, known arctic forms, appear later than the supposed tropical forms. In all excavations through glacial material the tropical forms with mammoth and woolly rhinoceros appear in the lower levels, never superficially; where several fossil beds are gone through, the upper or superficial beds contain the reindeer more abun-

dantly; where the reindeer occurs in the lower levels associated with the mammoth, woolly rhinoceros, hyena, etc., it is not abundant.

It seems more reasonable to suppose that these tropical forms were adapted to the cold climatal conditions in some way, as the mammoth and woolly rhinoceros were, or that the conditions were not as severe as the immense accumulations of ice would lead us to imagine, for, as we have seen, if the precipitation is great, the mean temperature need not necessarily be very low.

Prof. James Geikie thinks that during the Glacial epoch there were periods of high temperature, when the glaciers retreated and tropical animals migrated into the glacial region. However this may be, it is evident from what has been said that these tropical animals, with the woolly rhinoceros and mammoth, were either interglacial or preglacial or both. These data are important, as they fix the age of the associated human remains.

There is considerable diversity of opinion as to the value of the evidence of man's existence prior to the Pleistocene or early Quaternary—such evidence as we have being open to criticism or at least to the objection that it is not conclusive; it is founded principally upon roughly worked flints and flint chippings, perhaps and perhaps not made by man, as their occurrence can, at least to the satisfaction of some, be otherwise accounted for; also upon fossil bones of extinct mammals that bear markings supposed to have been made by contemporaneous man. Such bones have been found in both Pliocene and Miocene formations, and their incisions differently interpreted by different naturalists. Quite recently Prof. Cope has found in the Pliocene of southwestern Oregon obsidian implements of human manufacture associated and interbedded with remains of fossil birds, but by what agency they got there has not been determined.

The argument has been advanced as to Miocene man that, as all the mammalia of this period are extinct, it does not appear reasonable that man alone should survive the causes that proved so fatal to the rest of the mammalia. Against this it may be urged that man's superior intelligence would enable him to overcome adverse circumstances that would prove destructive to other forms. In fact, this superior intelligence may have been a potent factor in the destruction of the other forms.

In 1863 M. Desnoyes found in the gravel pit of Saint Prest, near Chartres, a leg bone (tibia) of a rhinoceros. It bore marks resembling those undoubtedly made by man on other more recent bones. Reasoning by analogy, the marks on the Saint Prest bone are also supposed to have been made by man. In the Victoria cave, Yorkshire, there was found a human leg bone (fibula). Both of these deposits have been considered by competent au-

thority to belong to the transition period between the Pliocene and Pleistocene.

In the year 1700, at Cannstadt, Würtemberg, Germany, there was found a portion of a human skull associated with animal remains. Its value was not known until 1835, when Jaeger recognized its importance as evidence of the coexistence of man with the extinct mammals. This appears to have been the first true fossil of man found.

In 1857 a human skeleton was discovered in a limestone cave in the Neanderthal gorge near Hochdal, between Düsseldorf and Elberfeld, Prussia, associated with remains of extinct mammals.

Spy Man. Modern Man. Spy Man. Modern Man. Spy Man. Modern Man.

FIG. 5.—SHOWING LEG BONES. (From Fraipont and Lohest.)

Unfortunately, the value of this find was not known to the workmen who made it, and most of the skeleton was lost. Dr. Fuhlrott, however, succeeded in securing the cranium, both thigh bones, two arm bones (a right radius and a left humerus), and a hip bone (left ilium). In the same year these were described by Dr. Schaffhausen. All the facial bones were lost. The cranium consists only of that portion situated above the roof of the orbits and the superior occipital ridges. This skull has become famous, and is known as the Neanderthal skull. When first found its remarkable peculiarities gave rise to much discussion. Many naturalists considered it a special species or even genus; others con-

sidered it as intermediate between man and the apes, and at last, in order to find some place for it, it was regarded by many as the skull of an idiot.

The peculiarities that gave rise to these opinions consist mainly as follows: A long, narrow skull, a low, rapidly retreating forehead, and an exceptional development of the brow ridges (superciliary ridges); these are so prominent that there is a depression behind or between them and the frontal bone. They, moreover, coalesce in the middle line, making a deep depression at the root of the nose. The bones are also unusually thick, the whole configuration remarkable and decidedly apelike and brutal.

The other bones found are in keeping with the skull, being thick and characterized by the unusual development of ridges and depressions for attachment of muscles; they would indicate a stature of five feet six to five feet eight inches (1·68 to 1·72 metre).

The cranial capacity has been calculated to be 74·42 cubic inches (1,220 cubic centimetres), said to be equal to that of the Malays and superior to that of the Hindus of small stature. The cranial capacity of the most capacious gorilla skull yet measured is thirty-four and a half cubic inches, while the largest human skull had a capacity of one hundred and fourteen cubic inches, the mean European skull being from ninety to ninety-six cubic inches, so that, while in capacity there is a wide difference between the Neanderthal skull and the gorilla skull, there is also a wide difference between it and the European skull.

In what is known as the cephalic index this skull does not compare unfavorably with skulls of some existing races. The cephalic index is based upon the proportion between the antero-posterior and transverse diameters of the brain case. It is ascertained by multiplying the transverse diameter by one hundred and dividing the result by the antero-posterior diameter; this result is the cephalic index. When it is less than eighty the skull is said to be dolichocephalic, or long-headed; when more than eighty the skull is brachycephalic, or short-headed. The antero-posterior diameter of the Neanderthal skull is eight inches, the transverse diameter 5·75 inches; the cephalic index is therefore seventy-two, and the skull is dolichocephalic, having an index less than eighty. The mean cephalic index of the existing Eskimos is 69·3.

Similar crania have been found in the tufa beds of La Denise, in Auvergne, France; at Eguisheim, in Alsace; and in the lowest gravels of the plain of Grenelle. All these are long-headed, or dolichocephalic, and correspond in other characteristics, but none are so apelike and brutal. It was therefore until recently thought that the Neanderthal man was simply a more pro-

nounced or exaggerated specimen of a general type existing at that time.

The facial bones are wanting in all these skulls, but a skull found in the Forbes quarry near Gibraltar, unfortunately of doubtful geological horizon, but with facial bones intact, coincides very closely in craniological characters with the Neanderthal skull. These facial bones are rude and massive, the upper jawbone (superior maxillary) being sensibly prognathic, the nasal bones prominent, and the nasal orifices very broad; the dental arch is of horseshoe-shape, narrowing backward.

A lower jawbone found by Dupont in the cave of Naulette in the valley of the Lesse, Belgium, has been regarded as possibly belonging to a man of the Neanderthal type. This jaw is remarkable for thickness; the molar teeth increase in size backward, the wisdom tooth being the largest; there is also an absence of the chin prominence.

In the year 1886 MM. Fraipont and Lohest, two thoroughly competent scientific men, discovered two skeletons of the Neanderthal type (a man and a woman) at the mouth of a cave in the commune of Spy, in the Belgian province of Namur.*

These men of Spy were found in the terrace in front of a limestone cave or grotto (as represented on the screen, Fig. 2, by a section through the deposit) at the point E, after cutting through the formation A, nine feet six inches (2·9 metres) thick, composed of rubble and brown clay, containing calcareous blocks of several cubic metres volume; B, a yellow argillaceous tufa, two feet seven inches (0·8 metre) thick, containing calcareous blocks and difficult to cut with a pick; C, about six inches (15 centimetres) thick, of strong red color, containing flint chippings, angular fragments of limestone, charcoal, and *débris* of mammoth tusks; D, also about six inches (0·15 metre) thick, a yellow calcareous clay passing into a tufa of same nature as B, at the base of which is a small vein of wood charcoal; F, brown clay, sometimes black, containing angular limestone pebbles and flint chippings, under which is the limestone in which the cave is formed, K.

There are no fossils in A, nor at the point where the opening is made were any found in B; but the bed B was found to be fossiliferous at other points, containing bones of mammoth and deer, and toward the upper part, in discontinuous layers, flint chippings. The zone C, above the human bones, is a hard breccia, resisting the blow of a hammer, and composed of fragments of mammoth ivory, flint chippings, angular calcareous pebbles, and pieces of wood charcoal. The continuity of this zone C, the fact

* Rech. ethnograph. sur des ossiments humaines, par Julien Fraipont et Max Lohest. Archives de Biologie, vii, 1886.

that the human bones were contained in a very hard bed, from which they were removed with difficulty, together with the careful examinations of MM. Fraipont and Lohest at the time of finding, preclude any hypothesis of burial or change of position due to reworking of strata.

Fig. 6.—Skull of the Man of Spy. From Prof. G. F. Wright's Man and the Glacial Period. (From a photograph.)

The only logical conclusion is, that the men of Spy died at the entrance of the cave that served them for a home, on the ground that was partly formed of their kitchen *débris*. The animal remains found on a level with and below the Spy skeletons were woolly rhinoceros (abundant), fossil horse (very abundant), red deer (rare), reindeer (very rare), aurochs (plentiful), mammoth (common), cave bear (rare), badger (rare), cave hyena (abundant). The utensils found at the side of the skeletons were two triangular pointed flint instruments dressed on one face, a thin polished sandstone, many unformed flint splinters, and a bone instrument.

If we adopt the classification of Quaternary man, based on the associated fauna and archæological remains, proposed by M. de Mortillet, this man of Spy belongs to the Moustieriennes period. M. de Mortillett recognizes a Quaternary human station earlier than this, but from it there have been no human bones reported.

The two fossiliferous beds, C and B, above the skeletons, also contained archæological remains. Without taking time to describe these, it may be stated that both beds contained flints of the same type as those in the bed with the skeletons; also bone and ivory instruments. The flint instruments were more elaborate in workmanship and finish, progressively so, being more so in B than in C.

MM. Fraipont and Lohest regard the men of Spy as being of the same age and type as the Neanderthal and Cannstadt men.

The superimposed outline drawings (upon the screen) of a side and top view of the skulls, in which the solid line represents the

Neanderthal, the dotted line Spy man No. 1, and the broken line Spy man No. 2, show how closely they coincide, especially in the case of Spy man No. 1, which is scarcely distinguishable from the Neanderthal. The skull of Spy man No. 2, while retaining the general characteristics of the Neanderthal, is more arched and higher in the frontal region. The cephalic index of Spy No. 1 is seventy; that of Spy No. 2, seventy-four to seventy-six.

The immensely developed brow ridges (superciliary crests) are not known in any existing race, nor is the rapidly retreating forehead, except in rare and isolated cases. Both are well-known characters in the *Simiidæ*. The characters exhibited by the lower jaw are remarkable, and are presented by no existing human race. The angle formed by the anterior face of the mandibular symphysis with the inferior border of the horizontal ramus (that is, the angle between the chin and the lower jaw) is an obtuse angle, while in all existing races it is an acute angle. There is no chin prominence in the Spy men.

The posterior face of the mandibular symphysis (that is, separating the lower jaw at the chin and exposing the separated faces) presents characters approaching an outline intermediate between the anthropoid apes and existing man, as illustrated on the screen by outline drawings of the symphyses of the chimpanzee, Spy No. 1, Spy No. 2, and modern man. By comparing the corresponding parts as represented by the letters this will be evident. Thus the concavity P exists in the chimpanzee and Spy No. 1 and No. 2, but is scarcely discernible in existing man; the prominence G exists in the chimpanzee, Spy No. 1 and No. 2, and is scarcely discernible in existing man. The concavity T has the same relation; the prominence B, for the insertion of the genioglossal muscles, exists in all; and from this point the outline slopes rapidly forward in existing man and Spy No. 1 and No. 2, while less so and to a less defined termination in the chimpanzee. The upper part of the outline, except that it is more vertical, corresponds more nearly with the chimpanzee, while the lower part corresponds more nearly with existing man.

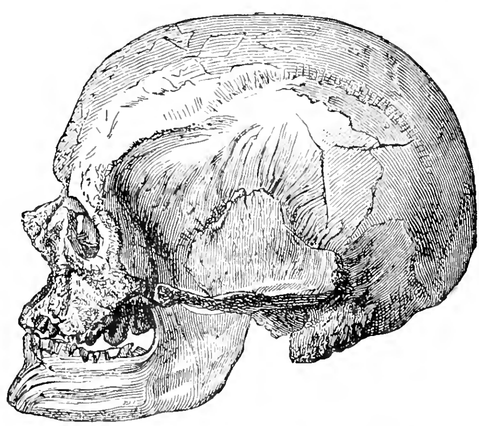


FIG. 7.—SKULL OF THE OLD MAN OF CRO-MAGNON, EYZIES. (Reindeer epoch.)

The absence of the chin prominence is also shown in these views. As will be noticed, the line A C, let fall from the anterior superior angle of the symphyses, falls entirely outside of the rest of the anterior outline in the chimpanzee, Spy No. 1, and Spy No. 2, while in modern man it cuts the outline, leaving a considerable prominence anterior to it.

The molar teeth increase in size posteriorly. Prof. Cope, from an examination of the teeth from casts furnished him by M. Lohest, points out many interesting peculiarities in dentition, prominent among which is the fact that the superior molar teeth are quadrituberculate. In Europeans they are generally trituberculate. In some lower races—Malays, Polynesians, and Melanesians—they are quadrituberculate, as they are also in the anthropoid apes. The bones of the forearm, radius, and ulna are so curved as to produce a wide interosseous space, not observed in any existing race, but common in apes.

The thigh bone, or femur, is round in section and curved anteriorly. This is only known among existing races in the Negritos of the Philippine Islands. It is normal among apes.

The tibia has an oval section, and is shorter in relation to the femur than in any existing race. This is also a simian character.

The condyles of the femur are wide, and are more produced posteriorly than in any existing race.

The articulation between the femur and tibia is such that the men of Spy must have walked with a fixed bend at the knees. Moreover, the body must have been bent forward in order to preserve equilibrium. These men were of short, powerful build.

In general the man of Spy presents many simian characters, but he is still distinctively a man. To use the words of MM. Fraipont and Lohest, between him and the highest apes there is "an abyss"; to which Prof. Cope adds, "though, from a zoölogical point of view, it is not a wide one."

On the other hand, this man of Spy presents characters that seem to distinctly define and separate him specifically from all other known races of men. In recognition of this fact, the name *Homo neanderthalensis* has been proposed for him.

MM. Quatrefages and Hami regard the Cannstadt man and the Neanderthal man as being of the same age and type, and have classified with them the crania found at La Denise, Eguisheim, and in the lowest gravels of the plain of Grenelle, under the name of the Cannstadt race. As before stated, MM. Fraipont and Lohest consider the Spy man to be of the same age and type, referring it also to the Cannstadt race. Of this race Quatrefages says: "It disputed the ground with the great extinct mammals, with the mammoth, the woolly rhinoceros, the cave bear, and the cave hyena; it belongs, therefore, to the earliest ages of the Qua-

ternary." Dr. Schaffhausen thinks it can be traced to an earlier period still. In view of the discovery of the Spy man with its better definition of the Cannstadt race, it is possible that the men of La Denise, Eguisheim, and the lowest gravels of Grenelle will have to be separated from this race.

In the valley of the Vézère, in the southwest of France, in that of the Somme in the northwest of France, at Grenelle near Paris, in the Gourdon grotto in the middle of the central Pyrenees, in the department of the Basses-Pyrénées, in the valley of the Meuse in Belgium, and in several other localities needless to

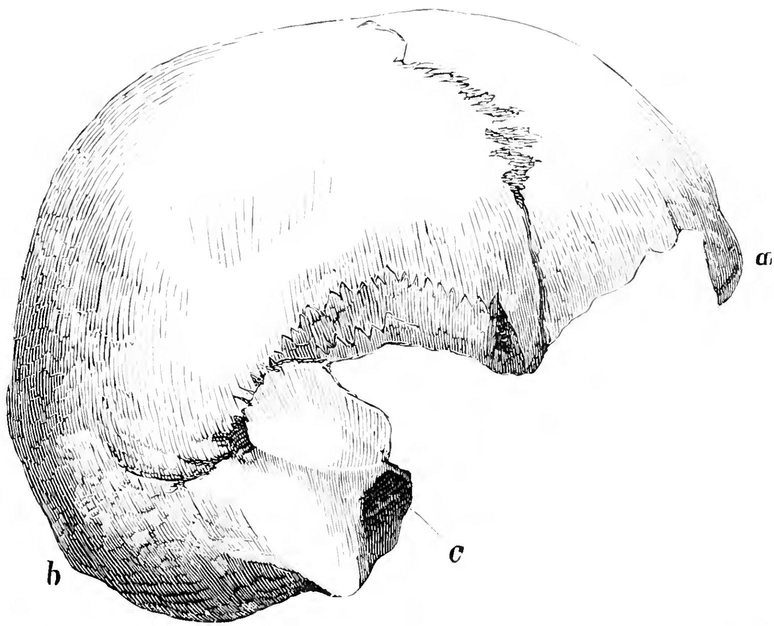


Fig. 8.—The Skull from the Cave of Engis—viewed from the right side. *a*, glabella, *b*, occipital protuberance (*a* to *b*, glabello-occipital line); *c*, auditory foramen. (From Huxley's Man's Place in Nature.)

repeat here, there has been found a fossil man, morphologically much different from the Cannstadt man.

To this man MM. Quatrefages and Hami have given the name of the Cro-Magnon race, from the rock shelter of this name in the valley of the Vézère, near the village of Les Eyzies, where in the year 1858 the bones of three men, one woman, and a child were found.

This race is regarded as more recent than the Cannstadt race. The evidence to sustain this view is quite convincing.

In the Grenelle basin, near Paris, the Cannstadt man, the Cro-Magnon man, and a skeleton approaching a type known as the Furfooz man (to be described later) appear in chronological order,

superimposed one upon the other, the Cannstadt race occupying the lowest gravels, the Cro-Magnon race the alluvial beds at a depth of ten to thirteen feet, and the Furfooz race at a depth of five to eight feet.

The Cro-Magnon skull is similar to the Cannstadt in one particular only—they are both dolichocephalic, long-headed—the cephalic index of that of the old man of Cro-Magnon being 73·76, that of the Engis skull from the Meuse, Belgium, being 70·52; so that we have in both races long, narrow skulls, but here the resemblance ceases. The forehead of the Cro-Magnon skull is well proportioned, rising above brow ridges (superciliary ridges), but slightly marked in some instances, better defined in others, but never excessively prominent and apelike as in the Cannstadt skull. The vault presents fine proportions, tne calculated capacity being 96·99 cubic inches (1,590 cubic centimetres). This is higher than the mean capacity of existing European skulls.

The facial bones indicate the type of heads called by Pruner Bey disharmonic—that is, a head with a skull elongated from before backward and a face elongated from above downward is harmonic. When there is a disagreement in these proportions it is disharmonic. In this case the face is broad while the head is long. The eyes were small, the nose bold and narrow. The maxillary bones projected outward, so as to produce decided prognathism; the chin projects forward; in stature they were tall, measuring from five feet ten to six feet eight inches. All the bones of the skeleton are solid, thick, and indicate a powerful people.

In the valley of the Vézère within a distance of seven or eight miles there have been found eight settlements of this race. I will not detain you to enumerate these or describe them separately. Suffice it to say that, while the remains are all undoubtedly of the same race, the associated animal and archæological remains indicate clearly that they are not of the same age, but rather those of successive periods of development; thus the eight settlements give, as it were, an epitomized history of the race.

The most ancient, being connected by its fauna with the lower alluvium of Grenelle, the men of this period were probably little superior to the Cannstadt race. In the next settlement, that of Cro-Magnon itself, the arms and implements were more numerous and varied, though lighter and made of flint; the large animals—mammoth, bear, and hyena—were still killed for food. In other more recent settlements the cutting of flints was developed to a marvelous perfection; arrowheads, spear and lance points were made with much care and finish.

In the most recent settlements when the reindeer predominated the industry underwent a change. Bones and the antlers of reindeer were fashioned into weapons, while flint appears to have

been used for tools only. They made harpoons, barbed arrow-heads, and needles not much longer than our own, with pierced eyes. Burned wood and ashes are evidence of their knowledge of fire and perhaps cooking, though no vessels for this purpose have been found. From the needles it is a fair inference that they made clothes out of the skins of animals. They also carved with flints on the bones of animals, some of these of fair artistic merit;

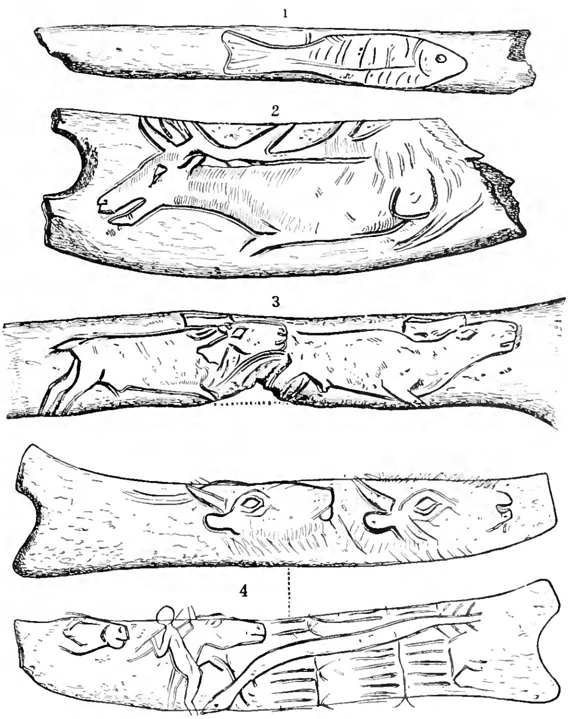


Fig. 9.—Delineations on Pieces of Antler (La Madelaine). 1. Drawing of a fish on reindeer horn. 2. Representation of a squatting stag on stag horn. 3. Running reindeer on reindeer horn. 4. Piece of reindeer horn, showing on one side two heads of the aurochs, and on the other a human figure, an eel (?), two horse heads, and three rows of marks. The portions which would not be visible, owing to the roundness of the piece of horn, have been drawn beyond its contour.

most of the representations are of animals, few attempts being made at the human form, and these not good. They visited the seashore, as marine shells are found, and from the character of the burial places the inference is fair that they had some idea of a future existence.

The skeleton found in the cave of Mentone in the Mediterranean (just east of Nice) was probably of this race.

Toward the latter part of the time of the predominance of the reindeer there is a decrease in the bone implements found, and a greater finish is noted in the flint implements; no doubt, with the

amelioration of climate, retreat of the glaciers, and consequent moving northward of the reindeer, the conditions of existence materially changed. It is maintained by some naturalists that the man of Cro-Magnon followed the reindeer north, that the settlements remained for a long time uninhabited, and that the man who made the polished flint implements is another and distinct race—neolithic man, the earliest man of the present period. On the other hand, it is held that the polished flint race is but a development of the Cro-Magnon. In support of this it is claimed that in the upper levels of a rock shelter at Sorde, in the department of the Basses-Pyrénées, human bones of the Cro-Magnon type and cut flints were found, but with them a narrow, thin

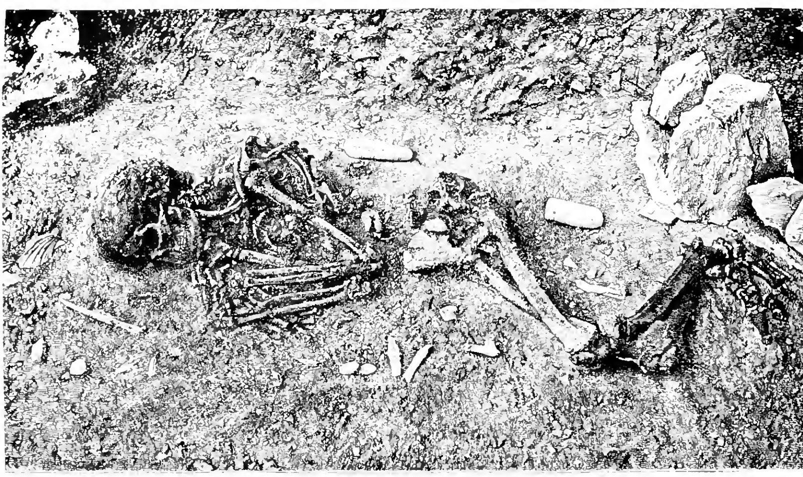


Fig. 10.—Prehistoric Man from the Cave of Mentone. (From Dana's Manual of Geology.)

blade and a triangular dagger, which are very similar to the finest productions of the neolithic age. The most plausible conclusion would seem to be that many, but not all, of the Cro-Magnon men followed the reindeer and retreating ice northward, and that those remaining amalgamated with the neolithic immigrants, accepting in a measure their industries; thus we have the mixtures of the implements of palæolithic and neolithic man.

The most recent of the races of fossil man have been grouped by MM. Quatrefages and Hami under the name of the Furfooz race, from Furfooz in the valley of the Lesse, Belgium; here a complete station, comprising a grotto where they lived and a burial grotto, was found. As before mentioned, a race allied to this is found in the Grenelle basin near Paris. Grouping on craniological characters, and considering a head found at La Touchère in a bank of the Seille as an allied form, we have in this group

four types. They are all short heads (*brachycephali*), the first Furfooz race having a cephalic index of 79·31; the second, 81·39; that of Grenelle, 83·53; that of La Touchère, 84·32. The La Touchère skull is remarkable for a disharmony the inverse of that of the Cro-Magnon. In this case the skull is broad and short while the face is long.

The two races of Furfooz have a family resemblance, but are distinctive types: in the first the head is harmonic, the forehead retreating, the face broad, a sufficiently prominent nose, square orbits, and an almost orthognathous superior maxillary; in the second Furfooz race the forehead rises somewhat perpendicularly, the orbits and the face are longer, and the superior maxillary projects forward, producing a decided prognathism. In the Grenelle race the brow ridges are full and give a slightly oblique direction to the base of the forehead, but the arc soon rises and is regular, the head is harmonic, the cheek bones are prominent, the orbits approach the square form, the nose is sufficiently prominent, and the maxillary bones are prognathous. The men of Grenelle and Furfooz were of small stature, five feet four to five feet six inches. The bones of the limbs and trunk are strong.

Some investigators are disposed to regard these Furfooz races as neolithic or belonging to recent times, but the associated animal forms seem to place them among the Quaternary forms, though perhaps near the close of the Glacial period. The remains of their handicraft would indicate a peaceable people. Their implements were made of flint and reindeer horn. Knives, saws, scrapers, and bodkins were made of the former, and lances or javelins of the latter. The workmanship was inferior to that of the most recent Cro-Magnon men. Skins were used for clothing, and their burial places indicate a belief in another life.

It is probable that this race met with the same fate as the Cro-Magnon; with the retreating ice the animals upon which they lived moved northward and to higher altitudes, the majority of the Furfooz men following, others remained stationary, and these were eventually absorbed by long-headed and short-headed men of the neolithic or polished stone period.

Pruner Bey advanced the hypothesis that this brachycephalic race were the ancestors of a so-called Mongoloid type of man, he considering that a type of man exists uniting the characters of the Mongol proper and the white races, and extending over the greater portion of the north of the old continent and even into America.

While, so far as our knowledge goes, the long-headed races antedated the short-headed, there is no evidence that the latter descended from the former. As we have seen, the long-headed Cro-Magnon and the short-headed Furfooz both had representa-

tives in the reindeer period. No doubt these fossil races, modified by intercrossing and other causes, persisted up to present times.

In this connection it may be well to refer briefly to the contention now prevailing as to the origin and original habitation of the ancestors of the present inhabitants of Europe. This subject, very interesting, is full of difficulties, which open it up to speculation and give full play to that class of scientists whom Prof. Huxley has called the Uhlans of science. Philology seems to take precedence in these investigations. The long-recognized similarity in the so-called romance languages—French, Italian, and Spanish—led Sir William Jones, about a century ago, to point out the alliance between Sanskrit, Zend, Armenian, Greek, Latin, Lithuanian, Slavonian, German, Celtic, etc. Inasmuch as the similarity of French, Italian, and Spanish would be unintelligible if it were not for Latin, so the relation between all of the above-named tongues is unintelligible without a root tongue and a people who spoke it.

At first this honor was given to Sanskrit and the inhabitants of the valley of the Ganges. Subsequent investigations demonstrated that Zend and Sanskrit were modifications of an Indo-Iranian tongue, of which Zend and Sanskrit were offshoots. Then the region of the Hindu Koosh and Pamir was thought to be the original seat; this idea crystallizing, as it were, long held sway. As the people spread northwest into Europe and southeast into India, they were called the Indo-Germanic race, and have now come to be called the Aryan race, said to be the name by which the Persians and Hindus knew themselves before their separation.

More recently speculation as to the original seat of the Aryans has, we might say, run wild. Russia, Finland, the shores of the Baltic, Scandinavia, and the Caucasian region all have or have had their advocates. The claims made for the Caucasian region and Russia appear to be the most plausible. They are, moreover, to some extent complementary to each other.

For the first locality the principal reason advanced is philological. It is held that the root language would necessarily contain names for the familiar objects of the environment. As there appear to be no words in Aryan to represent certain animals—camel, lion, and tiger—it is supposed these forms did not exist in the locality; being unknown to the people, they had no names for them. Hence, by studying the confines of animal life, a locality where the unnamed life did not exist would fill the linguistic requirement. The Caucasian region is said to do this. This reasoning is, however, of the negative kind, and is open to the objections that all negative reasoning is.

The argument for the Russian locality is known as Latham's Sarmatian hypothesis. It takes for a starting point the position that one important prerequisite for the development of the Aryan race was that in its nascent stages at least it should be kept pure. It is well known to geologists that at a not very remote period Europe and Asia Minor were continuous across the Bosporus, the barrier being about two hundred feet above the sea. Going east from this point we encounter the Black Sea, at present on a level with the Mediterranean; the Caspian, eighty-five feet above; and the Aral, one hundred and fifty-seven feet above. Therefore, at the time that Europe and Asia Minor were continuous, all this area represented by the above-mentioned seas and the intervening land was one vast sheet of water, which in connection with the mountain ranges would effectually bar the progress of a non-maritime people, thus preserving it from contamination with other races and at the same time leaving it a vast area in which to develop. If the Aryan race existed at this time, this was no doubt an ideal place for its development. Moreover, the wide area covered gave room for considerable differentiation in language before it began to spread over India and the rest of Europe, as many dialects must have prevailed, with considerable difference between those of the central tribes and those of the periphery.

When by the erosion of the Bosporus the land was drained and assumed its present condition, the race is supposed to have spread in all directions. This spreading from a central point appears, in view of the great diversity of the Aryan languages, yet all with an Aryan root, as more reasonable than the hypotheses, like that of the Caucasian region, which necessitate their spreading in successive migratory waves.

As to the origin of the Aryan race all is as yet speculation. On this point the Uhlans have the field. That there was a race or a people speaking the root tongue of all the Indo-European tongues is beyond dispute, but that all the Indo-European people speaking the so-called Aryan languages are of this race is not so clear. Whatever the truth may be as to the original seat of the Aryan race and as to its origin, they seem to be a distinct people and not to have developed from fossil or palæolithic man, as we know him, unless perhaps Pruner Bey's idea (alluded to before) may prove to be true, viz., that the Furfooz man developed into a so-called Mongoloid race, and the Aryans are a division of this race.

We have seen in some of the abodes of fossil men described that there was evidence that they had mixed and acquired some of the customs of another, more advanced, so-called neolithic race. These neolithic men may have been and possibly were the pio-

neers of the migrating Aryans, and existing Europeans are no doubt the descendants of the union of the two—the Aryan language having in great measure or entirely replaced the mother tongue, perhaps a very crude one, of fossil man. It is, however, maintained by some investigators that palæolithic or fossil man died out, and that a period or hiatus existed between his time and the peopling of Europe by neolithic man.

In America we have one skull reported from Brazil, the Lagoa Santa skull, but of doubtful geological horizon. It is, however, figured as of the Cannstadt type. In the United States we have one skull from the gold sands under Table Mountain, California, known as the Calaveras skull. This find has met with much criticism.

Weapons and implements of palæolithic man have been reported from the Pacific coast, Minnesota, Indiana, Ohio, and the Atlantic coast in the Delaware River Valley. Investigators regard this man, whose existence is proved by weapons and implements rudely fashioned of argillite, as being interglacial. Prof. Holmes has within the past two months severely criticised the Minnesota and Ohio finds. The question here also arises, What became of him? Did he follow the retreating ice northward? for it seems pretty generally agreed that the American Indian, come from where he may, is not the descendant of palæolithic man.

We saw in the first part of this paper that there was no positive evidence of man prior to the Pleistocene period; nevertheless, man must have existed before that time, for during that period his known fossil remains covered a wide area, and when we take into consideration the few fossils that are preserved by the rocks in comparison to the whole number of any species that perish, it is evident that Pleistocene man must have been numerous; and, as he must have descended from antecedent man, there can be little doubt that he existed in Pliocene and perhaps Miocene times.

There have been many attempts made to measure the age of geological strata—none, however, that can be said to be satisfactory. Not only are any experimental data that can be used very uncertain indices of what actually took place in the remote past, but the bias of the experimenter in favor of this or that hypothesis is apt to be impressed on the result attained. It may be stated, however, that scientific opinion, based on careful observations and comparative computations from these observations, the details of which our time will not permit us to go into, seems now generally agreed that the Glacial period closed from ten to fifteen thousand years ago.

We must remember that fossil man existed in preglacial or interglacial times, long anterior to the close of the Glacial period.

All or some part of that period, when North America and Europe were for the most part covered with glacial ice, intervenes between the time of man's undoubted existence—the time of the Cannstadt, Cro-Magnon, and Furfooz races—and the beginning of the time figured by these *savants*.

PROFESSOR TYNDALL.

By Prof. T. H. HUXLEY.

PERSONAL, like national, history has its epochs; brief seasons, during which life is fuller than usual, and the present is more obviously pregnant with the future than at other times. For me, the year 1851 constitutes such an epoch. In November, 1850, I had returned to England after an absence, which not only extended over a considerable period of time, but covered the critical age of transition from adolescence to full manhood. In the course of these four years, largely spent in little-explored regions of the other side of the globe, I had been in the world as well as round it, and stored up varied experiences of things and men. Moreover, I had done some bits of scientific work which, as I was pleasantly surprised to learn on my return, were better thought of than I had, I will not say expected, but ventured to hope, when I sent them home; and they provided me with an introduction to the scientific society of London. I found the new world, into which I thus suddenly dropped, extremely interesting, and its inhabitants kindly disposed toward the intruder. The veterans were civil, the younger men cordial; and it speedily dawned upon my mind that I had found the right place for myself, if I could only contrive to stop in it. As time went on, I acted upon this conviction; and, fortune greatly aiding effort, the end of it was thirty odd years of pretty hard toil, partly as an investigator and teacher in one branch of natural knowledge, and partly as a half-voluntary, half-compelled man-of-all-work for the scientific household in general.

But the year 1851 has other and even stronger claims to be counted an era in my existence. In the course of the twelve months after my return, I made acquaintances which rapidly ripened into friendships, knit with such strong bonds of mutual affection and mutual respect, that neither the ordinary vicissitudes of life, nor those oppositions in theory and practice which will arise among men of mental constitutions diverse in everything but strength of will, nor, indeed, any power short of almighty Death, has been able to sunder them from that time to this. And among those friends who, as the years rolled on,

"... mir so oft
In Noth und Trübsal beigestanden,"*

to whom, indeed, I have found the old shikaree's definition of a friend, as "a man with whom you can go tiger-hunting," strictly applicable, almost the earliest was John Tyndall.

My elder by some five years, Tyndall's very marked and vigorous personality must have long taken its final set when we foregathered in 1851. The dyer's hand is subdued to that it works in; and, it may be, that much occupation with types of structure, elsewhere, is responsible for a habit of classifying men to which I was, and am, given. But I found my new friend a difficult subject—*incertæ sedis,* as the naturalists say; in other words, hard to get into any of my pigeon-holes. Before one knew him well, it seemed possible to give an exhaustive definition of him in a string of epigrammatic antitheses, such as those in which the older historians delight to sum up the character of a king or leading statesman. Impulsive vehemence was associated with a singular power of self-control and a deep-seated reserve, not easily penetrated. Free-handed generosity lay side by side with much tenacity of insistence on any right, small or great; intense self-respect and a somewhat stern independence, with a sympathetic geniality of manner, especially toward children, with whom Tyndall was always a great favorite. Flights of imaginative rhetoric, which amused (and sometimes amazed) more phlegmatic people, proceeded from a singularly clear and hard-headed reasoner, over-scrupulous, if that may be, about keeping within the strictest limits of logical demonstration; and sincere to the core. A bright and even playful companion, Tyndall had little of that quick appreciation of the humorous side of things in general, and of one's self in particular, which is as oil to the waves of life, and is a chief component of the worthier kind of tact; indeed, the best reward of the utterer of a small witticism, or play upon words, in his presence, was the blank, if benevolent, perplexity with which he received it. And I suppose that the character-sketch would be incomplete, without an explanation of its peculiarities by a reference to the mixture of two sets of hereditary tendencies, the one eminently Hibernian, the other derived from the stock of the English Bible translator and Reformer.

To those who have been privileged to become intimate with Tyndall, however, sketch and explanation will seem alike inadequate. These superficial characteristics disappeared from view, as the powerful faculties and the high purposes of the mind, on the surface of which they played, revealed themselves. And to

* ... have so often stood by me
In trouble and adversity.

those who knew him best, the impression made by even these great qualities might well be less vivid than that left by the warmth of a tenderly affectionate nature.

"If I pull through this it will be all your care, all your doing." These words (I give them from memory), uttered the night before his death, were meant for no ear but that of the tireless nurse, watcher, secretary, servant, in case of need, to whom they were addressed; and whose whole life had been, for many years, devoted to the one object of preserving that of her husband. Utterly hateful to me as are the violations of a privacy that should be sacred, now too common, I have sought and obtained permission to commit this, and take all responsibility for it. For the pitiful circumstances of Tyndall's death are known to all the world; and I think it well that all the world should be enabled to see those circumstances by the light which shines forth, alike on the dead and on the living, from the poor crumpled piece of paper on which these treasured words were, at once, recorded.

But I have wandered far from the year 1851 and its nascent friendships.

At that time Tyndall and I had long been zealous students of Carlyle's works. Sartor Resartus and the Miscellanies were among the few books devoured partly by myself, and partly by the mighty hordes of cockroaches in my cabin, during the cruise of the Rattlesnake; and my sense of obligation to their author was then, as it remains, extremely strong. Tyndall's appreciation of the seer of Chelsea was even more enthusiastic; and, in after-years, assumed a character of almost filial devotion. The grounds of our appreciation, however, were not exactly the same. My friend, I think, was disposed to regard Carlyle as a great teacher; I was rather inclined to take him as a great tonic; as a source of intellectual invigoration and moral stimulus and refreshment, rather than of theoretical or practical guidance. Half a century ago the evangelical reaction which, for a time, had braced English society was dying out, and a scum of rotten and hypocritical conventionalism clogged art, literature, science, and politics. I might quarrel with something every few paragraphs, but passing from the current platitudes to Carlyle's vigorous pages was like being transported from the stucco, pavement, and fog of a London street to one of his own breezy moors. The country was full of bowlders and bogs, to be sure, and by no means calculated for building leases; but oh the freshness and the freedom of it!

Our divergent appreciation of Carlyle foreshadowed the only serious strain to which our friendship was ever exposed. When the old Cavalier and Roundhead spirit woke up all over England

about the Jamaica revolt and Governor Eyre, I am afraid that, if things had been pushed to extremities over that unfortunate business, each of us would have been capable of sending the other to the block. But the sentence would have been accompanied by assurances of undiminished respect and affection; and I have faith that we should not have spoiled our lives by quarreling over the inevitable.

Carlyle's extraordinary peculiarities of style, even at his worst, were not, to me, the stumbling-blocks which they often proved to other people, who, in their irritation, would talk of them as affectations. Even admitting them to be indefensible, it seems to me that if he is chargeable with affectation at all (and I do not think he is), it is rather when he writes the classical English, say, of the Life of Schiller. As any one who ever heard Carlyle talk knows, the style natural to him was that of The Diamond Necklace.* These observations have a bearing on the adverse criticisms of a like kind, to which Tyndall was sometimes subjected. Modes of speech and action which some called mannerisms, or even affectations, were, in fact, entirely natural; and showed themselves in full force, sometimes with a very droll effect, in the smallest gathering of intimate friends, or with one or two on a hillside, from whom abundant chaff was the only response likely to come. I say, once more, Tyndall was not merely theoretically, but practically, above all things sincere; the necessity of doing, at all hazards, that which he judged, rightly or wrongly, to be just and proper, was the dominant note of his character; and he was influenced by it in his manner of dealing with questions which might seem, to men of the world, hardly worth taking so seriously. Of the controversies in which he became involved, some of the most troublesome were undertaken on behalf of other people who, as he conceived, had been treated with injustice. The same instinct of veracity ran through all Tyndall's scientific work. That which he knew, he knew thoroughly, had turned over on all sides, and probed through and through. Whatever subject he took up, he never rested till he had attained a clear conception of all the conditions and processes involved, or had satisfied himself that it was not attainable. And in dealing with physical problems, I really think that he, in a manner, saw the atoms and molecules, and felt their pushes and pulls. A profound distrust of all long chains of deductive reasoning (outside

* In reading the very positive conclusions, based upon differences of style, about the authorship of ancient writings, enunciated by some critics, I have sometimes wondered whether, if the two pieces to which I have alluded had come down to us as anonymous ancient manuscripts, the demonstration that they were written by different persons might not have been quite easy.

mathematics), unless the links could be experimentally or observationally tested at no long intervals, was simply another manifestation of the same fundamental quality. I was not overburdened with love for such dialectic festoon-work myself, but I owe not a little to my friend for helping to abolish as much as remained.

Once again, this quality of active veracity, the striving after knowledge as apart from hearsay, lay at the root of Tyndall's very remarkable powers of exposition, and of his wealth of experimental illustration. Hence, I take it, arose the guarded precision of the substance of a lecture or essay, which was often poetically rich, sometimes even exuberant, in form. In Sir Humphry Davy and Mr. Faraday the Royal Institution had possessed two unsurpassed models of the profound, yet popular, expositor of science. Davy was before my time, but I have often had the delight of listening to Faraday. An ineradicable tendency to think of something else makes me an excellent test-object for oratory; and he was one of the few orators whom I have heard to whom I could not choose but listen. It was no mean ordeal, therefore, to which Tyndall was subjected when he was asked to give a "Friday evening" in 1852; but he captured his hearers so completely that his appointment to the Fullerian Professoriate of Physics, with the use of a laboratory such as he needed for the original work he loved, soon followed. And for more than thirty years he held his own. From first to last, the announcement of a Friday evening by him meant a crammed theater.

Sheridan's reply to the lady who told him that his writings were such charmingly easy reading—"Easy reading, madam, is damned hard writing"—has never got into the general mind; and very few of the thousands of delighted listeners, I imagine, ever had an inkling of what these facile discourses cost the lecturer. I used to suffer rather badly from "lecture fever" myself; but I never met with anyone to whom an impending discourse was the occasion of so much mental and physical disturbance as it was to Tyndall. He was quite incapable of persuading himself, or of being persuaded by others, that, after all, a relative failure, now and then, was of no great consequence; indeed, from the point of view of pure art, might be desirable. Whatever he gave, it must be the best he had, whether it were a lecture or a dinner. Now that sort of housekeeping costs. But some think with Shakespeare:

> "The painful warrior, famoused for fight,
> After a thousand victories, once foiled,
> Is from the book of honor razèd quite,
> And all the rest forgot for which he toiled."

And Tyndall was not minded to be forgot; at any rate, for that reason.

In the autumn of 1851, my friend and I went to the meeting of the British Association at Ipswich, as scientific "items" not, indeed, wholly unknown to the "pillars" of that scientific congregation; and perhaps already regarded as young men whose disposition to keep their proper places could not, under all circumstances, be relied upon. Being young, with any amount of energy, no particular prospects, and no disposition to set about the ordinary methods of acquiring them, we could conduct ourselves with perfect freedom; and we joined very cordially in the proceedings of the "Red Lion Club," of which I had become a member in London, and which had been instituted by that most genial of anti-Philistines, Edward Forbes, as a protest against Dons and Donnishness in science. With this object, the "Red Lions" made a point of holding a feast of Spartan simplicity and anarchic constitution, with rites of a Pantagruelistic aspect, intermingled with extremely unconventional orations and queer songs, such as only Forbes could indite, by way of counterblast to the official banquets of the Association, with their high tables and what we irreverently termed "butter-boat" speeches.

*Fuimus!** The last time I feasted with the "Red Lions" I was a Don myself; the dinner was such as even daintier Dons than I might rejoice in; and I know of only one person who, under a grave, even reverend, exterior, lamented the evolution of "Red Lionism" into respectability.

It was at the Ipswich meeting, that Tyndall and I fell in with Hooker, just returned from the labors and perils of his Himalayan expedition, and who was to make a third in the little company of those who were, thenceforward, to hold fast to one another through good and evil days. Frankland had long been a friend of Tyndall's, Lubbock soon joined us; and it was we four who stood, pondering over many things, in Haslemere Churchyard the other day.

Tyndall became permanently attached to the Royal Institution in 1853, while I cast anchor in Jermyn Street, not far off, in the following year. Before reaching this settlement, we had both done our best to expatriate ourselves by becoming candidates for the chairs of Physics and of Natural History in the University of Toronto, which happened to be simultaneously vacant. These, however, were provided with other occupants. The close relations into which we were thrown, on this and many subsequent occasions, had the effect of associating us in the public mind, as if we formed a sort of firm; with results which were sometimes inconvenient and sometimes ludicrous. When my wife and I went to the United States in 1876, for example, a New York paper was good enough to announce my coming, accompanied by my "titled

* We were.

bride"—which was rather hard upon plain folk, married twenty-one years, and blessed with seven children to boot.*

My friend's exploits as a mountaineer are sufficient evidence of his extraordinary physical vigor. I could manage a fair day's work in reasonable up-and-down walking myself, but I lacked his caprine sureness of head and foot; and, when it came to climbing, I was nowhere beside him. By way of compensation, I stood the wear and tear of London life better, though I had not much to boast of, even in that respect. From the first, Tyndall suffered from sleeplessness, with the nervous irritability which is frequently cause and consequence of that distressing malady. It is not uncommon for this state of the nervous system to find a vent in fits of ill temper; but, looking back over all the long years of our close intercourse, I can not call to mind any serious manifestations of that sort in my friend. Tyndall "consumed his own smoke" better than most people, and though that faculty is worthy of the highest admiration, I suspect that the exercise of it tells a good deal upon the furnace. When things got bad with him, his one remedy was to rush off to the nearest hills and walk himself into quietude. Pleasant are the recollections, for me and others, of such hard tramps, it might be in the Lake country, or in the Isle of Wight; in the Peak of Derbyshire, or in Snowdonia. On such excursions Tyndall was the life of the party, content with everything and ready for anything, from philosophical discussion and high-flying poetics, to boyish pranks and gymnastic comicalities.

Sometimes we traveled further afield. Thus, in 1856, we made an expedition to Switzerland which had a large influence on Tyndall's future. In 1845 I had my first view of a glacier, at the head of the Lac de Gaube in the Pyrenees; and when, ten years later, I was led to interest myself seriously in geology, in connection with the study of fossils, I read all I could lay hands on about these curious rivers of ice. At the same time Tyndall was occupied with his important investigations into the effects of pressure in giving rise to lamination, and I naturally heard a good deal about what he was doing. It struck me that his work might throw some light upon the production of the veined structure of glacier ice; and one day, when he was dining with us, I mentioned the notion that had come into my head. The upshot was that we, then and there, agreed to go and look into the facts of the case for ourselves. *More suo*,† he would have nothing to do with speculation till that essential preliminary operation had been effected.

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* I have just received the report of a sermon, delivered on the 15th of December, 1893, by a curious curate, who, in his haste to besmirch the dead, abuses "the late Professor Huxley"!

† After his way.

To Switzerland accordingly we went, and I joined him at the Montanvert, where he had taken up his quarters with Dr. Hirst, who was, I think, the closest of all his friends. I have never visited the place since, but I am told that it now possesses a grand hotel. In our time there was nothing but a rough mountain auberge, opposite to which, on the glacier side of the road, was a hut for guides. Into this Tyndall moved his bed, as he could not bear the noise of the wooden house. Accommodation and fare were of the roughest; our *chef* was a singularly dirty old woman, who met all our suggestions about dinner with a monotonous "*C'est ça*" *—as if the stores of a Parisian restaurant were at her disposal—while, practically, our repasts were as uniform as her speech. But as we used to start for the Jardin, or other of the higher regions early, and rarely returned much before sunset, there was no lack of hunger sauce; while the condiment, which gives herbs a better flavor than stalled oxen, abounded. Tyndall's skill and audacity as a climber were often displayed in these excursions. On one occasion, I remember, we came upon a perpendicular cliff of ice of considerable height, formed on the flank of the glacier, which seemed to present a good opportunity for the examination of the structure of the interior. A hot sun loosening them, the stones on the surface of the glacier every now and then rattled down the face of the cliff. As no persuasion of ours could prevent Tyndall from ascending the cliff, by cutting steps with his axe, in order to get a close view of the ice, we had to content ourselves with the post assigned to us, of looking out for stones. Whenever any of these seemed likely to shoot too close we shouted, and Tyndall flattened himself against the cliff. Happily, no harm ensued; but I confess I was greatly relieved when my friend descended at his own pleasure, and not at that of a chance fragment of rock.

It was on this trip that we attempted the ascent of Mont Blanc direct from the Montanvert, with a couple of porters to carry the needful stores as far as the Grands Mulets; and a guide, who, as it turned out, was of the blind sort. I found I was by no means in training; and as, under the circumstances, any failure on my part would have obliged the others to give up the attempt, I determined to remain at the Grands Mulets. My friends and the guide set out before dawn, and should have been back in eight or ten hours at furthest. The weather was magnificent, and I should be puzzled to recall a morning spent in more entire enjoyment than that yielded by the wide and varied prospect from my temporary hermitage, in a solitude broken only now and then by a vagabond butterfly or a strayed bee, drifting upward. But when

* Which might be translated "All right."

the early hours of the afternoon glided away without any sign of my companions, and the sun got low, things began to look serious. Neither the people at the Montanvert, nor those at Chamounix, knew anything about our intentions. In our way from the Montanvert we had had to cross some troublesome crevasses, and I knew nothing about the route down to Chamounix. If any accident had happened to my friends I could not help them; nor could I reckon upon getting assistance from Chamounix, unless, perhaps, I set fire to the timbers which sheltered me. My anxiety and perplexity may be imagined, and at last, as it grew colder, I went into the hut to ponder over the situation. As I sat over the embers, trying to see my way to some clear conclusion, I suddenly heard the clink of an alpenstock upon the rock at the foot of the Grands Mulets. The sound has ever since been pleasant to my ear; and, rushing out, I saw the three slowly making their way up—Tyndall pretty well exhausted, for the first and last time I ever saw him in that condition; Hirst snow-blind; and the guide thoroughly used up. He had mistaken the route and led the party into all sorts of superfluous difficulties.

As we intended to have descended to Chamounix, without stopping a second night at the Grands Mulets, provisions were not over-abundant and there were no candles. I am proud to say I made myself useful in various ways; among other functions, performing that of a chandelier with a perpetual succession of lighted lucifer matches. We were soon a merry company; and the next day we descended in glory, to the great disgust of the orthodox guides of Chamounix, to whom an ascent of Mont Blanc, up to that time, had meant the organization of a large and profitable expedition.

The love for Alpine scenery and Alpine climbing, which remained with Tyndall to the last, began, or at any rate became intensified into a passion, with this journey; and, at the same time, he laid the foundations of his well-known and highly important work upon glaciers and glacier movement. His first paper on this subject was presented to the Royal Society in 1857, and bears my name as well as his own, in spite of all my protests to the contrary. For beyond two or three little observations, and perhaps some criticism, I contributed nothing toward it, and all that is important is Tyndall's own. But he was singularly scrupulous—even punctilious—on points of scientific honor. It would have been intolerable to him to have it supposed that he had used even suggestions of others, without acknowledgment; so I, being thicker skinned, put up with the possibility of being considered a daw in borrowed plumes. The memoir became the starting-point of a long and hot controversy. While it was at its height, some supporters of the other side endeavored to throw the

weight of the award of one of the Royal Society's medals into the scale against Tyndall. It seemed to some of his friends, myself among the number, that this was unfair; and a lively battle, eventually decided in our favor, took place in the Council of the Society. I refer to these old troubles, merely for the purpose of finally removing the impression, if any such remains, that Tyndall had anything, directly or indirectly, to do with what took place. On the contrary, the two persons who were chiefly responsible, thought it desirable that he should be absolutely ignorant of what was going on; and I can answer for it that he remained so until long after, when, rummaging among my papers, I found some documents which I labeled "Ashes of an old fire," and sent to him.

Tyndall was a highly esteemed and popular member of the Royal Society and always loyal toward it; but the sensitiveness to which I have alluded led him, very early in his career, to do what, so far as I know, nobody had done before, nor has done since. In 1853, the Society awarded one of the two royal medals to him, the other recipient being Charles Darwin. Unluckily, one of the members of the Council, a person of high scientific position, who had wished to dispose of the medal otherwise, took his defeat badly; and, being a voluble talker, exhaled his griefs with copious impropriety to all and sundry. As soon as the report of this reached Tyndall's ears, he wrote a polite note to the senior secretary declining the honor. Frankly, I think my friend made a mistake. The Council was in no way responsible for the ill-judged and, indeed, indecent proceedings of one of its members; and perhaps it is better to leave an enemy alone than to strike at him with the risk of hurting one's friends. But, having thus sacrificed at the altar of strict justice, I must add that, for a young man starting in the world, to whom such recognition was of great importance, I think it was a good sort of mistake, not likely to do harm by creating too many imitators.

As time went on, as the work became harder, and the distractions of life more engrossing, a few of us, who had long been intimate, found we were drifting apart; and, to counteract that tendency, we agreed to dine together once a month. I think, originally, there was some vague notion of associating representatives of each branch of science; at any rate, the nine who eventually came together—Mr. Busk, Dr. Frankland, Dr. Hirst, Sir Joseph Hooker, Sir John Lubbock, Mr. Spencer, Mr. Spottiswoode, Tyndall and myself—could have managed, among us, to contribute most of the articles to a scientific encyclopædia. At starting, our minds were terribly exercised over the name and constitution of our society. As opinions on this grave matter were no less numerous than the members—indeed, more so—we finally ac-

cepted the happy suggestion of our mathematicians to call it the *x* Club; and the proposal of some genius among us, that we should have no rules, save the unwritten law not to have any, was carried by acclamation. Later on, there were attempts to add other members, which at last became wearisome, and had to be arrested by the agreement that no proposition of that kind should be entertained, unless the name of the new member suggested contained all the consonants absent from the names of the old ones. In the lack of Slavonic friends this decision put an end to the possibility of increase. Once in the year there was an outing, to which our respective wives were invited.

If I remember rightly, the meetings of the *x* Club began early in the sixties. They were steadily continued for some twenty years, before our ranks began to thin; and, one by one, "*geistige Naturen*" (departed spirits), such as those for which the poet * so willingly paid the ferryman, silent but not unregarded, took the vacated places. Tyndall was a constant attendant and a great promoter of vivacious conversation, until his health failed. Two years ago, a deep gloom was cast over one of our meetings by the receipt of a telegram to the effect that he had but few hours to live, and his partial recovery, at that time, was a marvel to all who knew his condition. I believe that the "*x*" had the credit of being a sort of scientific caucus, or ring, with some people. In fact, two distinguished scientific colleagues of mine once carried on a conversation (which I gravely ignored) across me, in the smoking room of the Athenæum, to this effect: "I say, A, do you know anything about the *x* Club?" "Oh, yes, B, I have heard of it. What do they do?" "Well, they govern scientific affairs; and really, on the whole, they don't do it badly." If my good friends could only have been present at a few of our meetings, they would have formed a much less exalted idea of us, and would, I fear, have been much shocked at the sadly frivolous tone of our ordinary conversation. Assuredly Tyndall did not usually help us to be serious.

But I must bring these brief and too hurried reminiscences to a close. I believe that ample materials exist, and will be used, for a fitting biography: indeed, the putting these materials into autobiographical form was the final piece of work to which Tyn-

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* "Nimm dann Fährmann,	Take, ferryman,
Nimm die Miethe	Take triple fare,
Die ich gerne dreifach biete:	Which I freely offer thee;
Zwei, die eben überfuhren,	Two who just went over
Waren geistige Naturen."	Were departed spirits.

I quote from memory; but it is long since I read these verses, and more likely than not the citation errs.

dall, with his wife's aid, proposed to devote himself. With the exception of the investigations upon the aërial germs, which, though, strictly speaking, they might be continuations and amplifications of Pasteur's labors, yet had a very great effect in putting an end to the tough-lived speculations of the advocates of the so-called "spontaneous generation" hypothesis, Tyndall's later scientific labors do not lie within the competence of my judgment. On that point, I leave it to contemporary experts to speak; and to time to give the final verdict, which is not always such as contemporaries imagine.

Neither do I offer any remark about Tyndall's philosophical, religious, and political views; in respect of which my opinions might possibly be impartial; but nobody would believe that they were so.

All that I have proposed to myself, in writing these few pages, is to illustrate and emphasize the fact that, in Tyndall, we have all lost a man of rare and strong individuality; one who, by sheer force of character and intellect, without advantages of education or extraneous aid—perhaps, in spite of some peculiarities of that character—made his way to a position, in some ways unique; to a place in the front rank not only of scientific workers, but of writers and speakers. And, on my own account, I have desired to utter a few parting words of affection for the man of pure and high aims, whom I am the better for having known; for the friend, whose sympathy and support were sure, in all the trials and troubles of forty years' wandering through this wilderness of a world.—*Nineteenth Century.*

THE EUROPEAN LAW OF TORTURE.

By AMHERST W. BARBER.

It is a startling anachronism to an American reader of 1894 to stumble upon a large vellum-bound law-book of the last century, prescribing in minute detail all the rules and conditions that must attend the proper infliction of intense physical pain on persons merely accused of any offense, and containing an appendix full of engravings, given by royal authority as working drawings to govern every operation of legal torture. Such a relic of an almost forgotten system of law rests in obscurity at the national capital, intruding its grim savagery of language and its coldly fiendish pictures upon a few minds accustomed to the modern idea of gentleness to every living being.

This book, printed in obsolete and barbaric German, with marginal syllabus in monastic Latin, seizes on the mind with a grasp of horror, and brings back the reader again and again to

delve among its dry bones of ancient delusion and wrong. It reveals a wide field of ideas which not long ago ruled the "civilized" world, but now are forever put away. In fact, it exhibits with photographic accuracy the Inquisition of central Europe.

The prevalent idea of torture seems to be about as follows: That two or three centuries ago a wicked portion of a priesthood set up the Inquisition as a means of religious persecution, which, after all, was probably not nearly as bad as reported. Another class, somewhat better informed, can discourse at large of the Spanish and German Inquisitions, and describe their ghastly relics still shown in museums; while others, again, full of ignorant zeal, will denounce the whole subject as a base slander on human nature.

But comparatively few now realize the full truth that in various lands torture was the established method of authority to force prisoners to convict themselves of every sort of crime for more than a thousand years before the Holy Office was set up by churchmen; that it still survived in parts of Europe as an authorized court process for generations after they had abolished the Holy Office; and that the much-advertised doings of the Inquisition were but a few rough waves of that bloody ocean of wrong which flowed over Europe from the time of Herodotus down to the nineteenth century.

Books of reference give the facts mildly, softened from old authors inaccessible to the many. But one must beware of history written, perhaps, for partisan purposes or with sectarian bias. What is wanted to-day is scientific proof, impartial and unimpeachable. For this is a delicate matter of family history. In examining into the mental and moral condition of ancestors only three or four generations back, let us beware of hearsay evidence. But we shall be justified in the inquiry if we can obtain their own testimony and make them convict themselves in their own favorite style.

For this purpose the *Constitutio Criminalis Theresiana*, or criminal code of Austria and Hungary, put forth in 1769 under the imperial edict of Maria Theresa toward the close of her reign, outweighs a whole library of recent suppositions. This book contains three hundred and fifty folio pages, with one hundred and four articles or chapters arranged in two parts, prefaced by a lofty proclamation over her Majesty's hand and seal, ordaining and enacting it as the lawful code of her domain.

Part I is a general commentary upon crime and criminal process, beginning with this benevolent and modern principle: "The punishment of criminals is designed chiefly for the reformation of evil-doers." The subject of torture is reached in Article 38, where eleven large pages are devoted to an exhaustive treatise on its principles and practice. It is called in the text "*die pein-*

liche Frage," or the painful questioning. In this code of explicit directions reference is made to the pictures in the appendix, showing all the authorized apparatus for torture. They are drawn, lettered, and explained with the exactness of a patent drawing, and were not to be varied from in the least detail by the judicial operators. This treatise begins with the fundamental definition: "Torture is a lawful means of compulsion to bring to confession a denying malefactor, who, in the absence of full proof, has been strongly accused—or perchance to clear him from a burden of suspicion and accusation." This is paraphrased in the Latin note by saying that torture is a subsidiary means of tearing out the truth (*eruendæ veritatem*).

Part II takes up the whole calendar of crimes, arranged in forty-eight distinct classes, giving to each a brief separate treatise combining principles, law, exceptions, penalties, and questions to be used in the trial. More than three fourths of these chapters specially prescribe torture to make the accused convict himself. From blasphemy, the greatest crime in the list, down to the most trivial, a suspected person could in nearly every case be visited with deathly torment upon mere suspicion.

Human progress exhibits no contrast more surprising than is seen between the mercifulness of to-day and the cruelty of the past. What do we now observe as proofs that mankind does not now approve nor enjoy the bodily suffering of fellow-creatures? Human slavery largely abolished, with the stocks and whipping post; cruel punishments prohibited by the Constitution; capital punishment done away in various sections; painless execution introduced; all minor penalties reduced to fines and restraint of liberty, with good sanitation of prisons; anæsthetic medical treatment everywhere in use; corporal punishment in schools becoming unfashionable; humane societies interfering to prevent ill treatment of children and dumb beasts; and, especially, we see prisoners on trial permitted to sit unfettered and at ease, attended by weeping relatives to excite sympathy; allowed unequal advantages over the prosecution in the selection of a jury; given the benefit of every doubt, often of the most fictitious; furnished all opportunities for acquittal which money and dishonest counsel can procure; allowed to testify in their own behalf; and never required to give an answer that would tend to criminate themselves.

In contrast with this picture, take the manner of conducting trials under the elaborate rules laid down in the Theresian code. A man accused of felony, such as arson, sedition, sorcery, or poisoning, must be arrested, jailed, and brought to trial. If two or more so-called witnesses made oath that they believed him guilty, though no positive proof could be found, the court decreed it a *casus torturæ*, a proper case for torture, and proceeded to apply some pre-

scribed form of physical pain. An engraving shows one of the moderate methods. The victim's wrists are crossed behind the back and tied with a strong cord attached to a rope which passes over a pulley in the ceiling and down to a windlass. The *Henkersknecht*, or hangman's assistant, turns the windlass and the arms are strained upward, while the *Scharfrichter* (sharp judge, executioner) fiercely propounds the list of questions laid down in the code. In a trial for poisoning, for instance:

"Did you or did you not administer the poison that killed A. B.?

"When and where did you do it?

"For what reason?

"Who assisted or advised it?

"Who was present at the time?

"What sort of poison was it?

"Where and how did you procure it?

"Did the apothecary know your intended purpose?

"Have you ever poisoned others, or attempted it?

"What were the effects on the deceased?

"How long did he live after it? Was the body swollen? Did the nails turn blue or black? Did he froth at the mouth?" *Et cetera.*

The person undergoing torture (*der Inquisit*) of course stoutly denies each charge; so the servant gradually hoists him till he swings clear of the floor, with his arms undergoing backward dislocation, and the questions are thundered in his ears again and again as he whirls in dizzy agony. If able to persist in denial he is lowered for a brief rest, then raised again with a twenty-five-pound weight attached to the cord that bound his ankles, and the questions are repeated. If the man has unusual strength of body and will, he may still remain obdurate; in which case Theresa's code requires a third hoisting with a forty-six-pound weight added. This may or may not draw from his screeching lips words of confession, which the eager scribe will record, to seal his fate on the gallows or at the stake; but it can hardly fail to cripple him for life.

This is but one of the many ways enacted and vividly depicted in this code for "tearing out the truth," or "putting him to the question," as Shakespeare and other English writers denominate similar practices of our ancestors; for *quæstio* (seeking or inquiry) was the mild legal term for such proceedings ever since the days of ancient Rome. Wherever Roman conquests spread and the code of Justinian was fastened upon new possessions, there the torture system was ingrafted. Perhaps it was nothing new to the Gauls and Germans, but Greece and Rome are generally held responsible for its wide prevalence in ancient times.

The dangerous privilege of using these "methods for the discovery of truth" was greatly abused, and often carried to a fatal extreme. Through ages of unrecorded tyranny the party in power put down its enemies and all opposing thought by such unbridled cruelty as no one now cares to contemplate. The public conscience seemed to approve the principle of torture as a divine prerogative of kings. Barons, judges, priests—in brief, all great robbers and politicians—cherished it. The more humane monarchs, such as the Empress Theresa, could only limit its cruelties by precise and moderate safeguards, exempting from all torture the sick and feeble, the old men, pregnant women, young children, and weak-minded, and providing that medical and surgical skill be always at hand to restore those who are near death, and reduce dislocations or fractures.

In some of the histories and cyclopædias are misleading statements that torture was abolished from the Austrian dominions about the middle of the last century, whereas this Austrian code was promulgated nineteen years later. Again, it is recorded of Maria Theresa, after an account of her general European war of seven years, ending in 1748, that "she now turned her attention to the internal affairs of her states. She introduced numerous reforms, alleviated the burdens of the peasantry, abolished torture, and promoted industry." Her code, however, proves otherwise; for she had reigned twenty-one years after the peace of 1748 when she re-enacted these laws to perpetuate these terrible outrages on human justice. Whether she abolished it at all in the remaining ten years of her life is open to doubt. Other statements from the same sources, regarding the continuance and decline of the Holy Inquisition, appear equally questionable.

The study of such customs suggests strange and difficult questions. What sort of minds had those people? Did they possess conscience? If so, was it anything like the conscience of the moderns, who cherish the same sacred books? Was human justice then a false moral guide? Is it a true one now? Is human nature the same from age to age, or can it reverse itself while standing on the same basis? Was the woman-heart tender and sympathetic in those days? Or what sort of women reared the monsters who kept up torture for twenty centuries?

The persistence of that legal crime, in spite of all the morals, philosophies, and religions that held sway through those ages, is a hard and stubborn fact. Its phenomena seem to fit no favorite theory of general progress. What a world of intellectual power, of tender morality, of spiritual zeal, has blazed as with heavenly fire through those ages of unjust torment, without taking any concern in that system! It stood forth above all such influences like an upheaval of archaic rock which all the tides and storms of

progress had been powerless to beat down. Grecian culture and beauty did not care to assuage one pain. The magnanimity of Roman power did not hold out one merciful reform toward the suspected offender. Cicero wrote against the system, but all in vain.

The young nobility and students of Europe, flocking to great universities like Salerno in the middle ages, and learning from imported Arabic professors from milder Asia, do not seem to have acquired any noble horror of human cruelty. New religious sects arose and competed for public favor, but all were more ready to use torture than to condemn it. The leading minds of Europe were full of the New Testament, but they did not find legal torture referred to therein. Only the command not to suffer a witch to live seemed to fit the case.

A theory is greatly needed to harmonize these incongruous facts—a bright, clear, comprehensive, optimistic theory, creditable alike to humanity and the forces which guide human development. But such an explanation is not readily found. In default of a broad and able-bodied theory, fitted to carry us over all difficulties, one is left floundering among some unpleasant reflections. All races may have risen from barbarism. Before barbarism they may—just possibly—have come up from a still more brutish state. Yet this instinct of enjoying the torture of others can hardly be called a survival of brutishness, since animals do not seem to consciously practice cruelty; it is rather a distinguishing trait of mankind.

This element of savagery is a most persistent and incorrigible offender in the happy family of our virtues. How it has defied culture, development, moral training! In theory all advancing races should properly have this Canada thistle of our moral field pretty well eradicated by this time by the strong hand of social and religious development. But when it has been well dug out, burned up, and killed very dead, the weary reformer, resting on his hoe, sees the thorny shoots of human cruelty here and there pushing boldly up in new places, fresh from the ancient seeds of inherited brutality that still lurk in the soil. Yet he cheerfully begins anew, and attacks the inexhaustible evil with never-tiring zeal.

It is also depressing to reflect that all men have been savages in infancy; that children pass through the ascending grades of mere animal life; that each young pupil, rightly observed, has been a sample of slow or rapid evolution through the stages of cave-dweller, nomad, and barbarian, to the half-civilized or even a higher grade. The childhood of races reflects the development of individuals. In the rapid march of the infant mind there comes a time when it gives pleasure to see and produce suffering.

This part of the regular course is omitted by few, and in some cases is adopted as a ruling life-trait. This was probably the usual result in those early days.

Another discouraging obstacle to any pleasant theory is that apelike propensity for imitation which kept primitive races following the old tracks of their predecessors. Antiquated custom gave them inviolable laws, against which reason and justice might protest in vain. The mere imitative trait has sometimes ruled the action and belief of masses of mankind as surely and unthinkingly as it does a colony of the simian tribe or a community of cigarette-using boys.

A race of beings so tainted with original savagery, so ruled by imitation, and so averse to change, must have found it hard to abolish torture from the court-room. To accomplish the reform one of the grandest moral battles of the world had to be fought. An ethical rebellion against the allied powers of monarchy, hierarchy, and aristocracy had to be triumphantly carried through. Necessarily there were brave leaders, who went into the fray with their eyes open to the fate of Jerome and Huss, of an earlier age, who for having dared attack the sin of torture were burned alive by the offended Church.

It was but recently, speaking comparatively, that the Inquisition, both secular and ecclesiastical, was in full force, and that the reform mentioned was made successful. When the code before us was printed at Vienna, the present writer's grandfather was a youth of thirteen years. America was then already reformed from her imported sins against justice. The whirlwind of delusion which culminated at Salem had been over for seventy-seven years, and its reaction had blotted from the minds of most Americans much of the witch-belief of former ages. Benjamin Franklin had long been the ambassador of America to his king, pleading for political rights. England had partly reformed her cruel laws. Human torture was not legal in America, save under the cloak of African slavery.

Yet in the Theresian code, Article 38 is found filling eleven broad pages with the law of torture, as if it were a fundamental institution which would exist forever. It specifies the cases in which courts are warranted in using torture to induce confession, which seem worth giving in full:

When one is accused by one credible, sworn witness, aided by evidence of previous bad character.

When, after detection in the act, he boldly denies it.

When informed against by an accomplice.

When he has admitted the offense which was known to be committed.

When any two or more of the following causes concur to

show guilt, though singly they are not sufficient to incur torture, such as—

Previous bad character or worthless conduct.

Previous similar misdemeanors, either proved or rumored.

Being found in proximity to the crime.

Being seen with the appearance, dress, arms, or horse of the actual culprit, or approaching or leaving the spot.

The finding of any of his dress or weapons, or of his tracks in snow or earth.

His previous companionship or domicile with those who commit such acts.

Previous enmity, envy, or threats toward the injured person.

Dying declarations or sworn accusation by a person injured.

Absconding suddenly without good cause.

Altering his personal appearance, disguising, giving false excuses, etc.

To entitle the prosecution to obtain a decree for full torture of one accused of a capital crime (and most of the offenses were then capital), two or more of the above conditions must be shown to the satisfaction of the judge. The warrant must specify not only how many of the successive grades may be used, but just how long each process shall be applied. But in every case of torture a strange preliminary proceeding was required, called territion (*territio, Schreckung*), a mental torture, by terrifying the prisoner to extort confession through fear of pain. It was derived, like all the rest, from the ancients, whose law writers prescribed forms similar to those of the Austrian code.

Territion was of two grades—verbal and real. In verbal territion the judge exhorts the prisoner to confess, and tells him what pains await him; he describes the process vividly, with the executioner acting the scene in pantomime. The victim is fiercely seized by the hangman, dragged from the court-room down into the place of torment (*Marter-ort*), and shown the painful machines and their use. The executioner seizes him again and pretends to be about to apply them.

Verbal territion failing to secure admission of guilt, he resorts to the real. He seizes the *Inquisit* once more, drags him to the rack, binds him in place, but does not apply the ropes or screws to any painful extent. Returning him then to the court-room, they again solemnly warn him to confess his guilt, lest worse shall befall him. If he still remains obdurate, his day of grace is past; territion gives place to actual torture.

The code gives a few merciful limitations of this power. Idiots, invalids, feeble men over sixty, children, and, of course, all officials and clergy, are exempt; and women can only be subjected

to the two milder grades, the other two being reserved for men accused of atrocious crimes.

Then comes a minute and intricate code of procedure for those very common and puzzling cases when the sufferer pleads guilty under torture, but reasserts his innocence after it, declaring that the pain irresistibly drove him to make a false confession to obtain a brief respite. In such cases the judge is forbidden to "put him to the question" anew till he has certified the conflicting statements to a higher court, and received new orders to proceed. But the good empress commands that "beyond three times shall no one be tortured; but he who endures it three times without confession, or who has each time recanted his confession, shall be set at liberty, because he is sufficiently cleansed from the accusations by the martyrdom endured. And the martyr can not say that injustice was done him, for the judge has the evidence to justify his action," etc.

The four grades are then defined, the first being the thumbscrew (*polletrum, Daumstöcke*). Two separate forms are pictured by life-size scale drawings; one sort was legal in Austria and one in Bohemia. It is a strong little vise, seven inches long, of two flat iron bars connected by screw bolts. The thumbs are to be inserted to the first joint, and the inner surfaces are armed with toothlike points. While the questions are asked one servant helps hold the vise and turn the nuts with a wrench or key, while another clasps the victim tight around the body to prevent contortions. A third may or may not be employed to increase the pain by hammering on the vise.

The picture of this scene is very effectively drawn. The conflict of stubborn wills between the roaring victim and the iron-hearted bailiffs is fearful to witness. The judge is in no hurry; he gives the wrench an additional turn now and then till the very bones are crushed, and the clerk can triumphantly write down the confession of guilt.

The second grade, which is now seldom heard of, was the cord (*fidicula*). Its exact size and use are fully pictured. The arms of the accused are stretched forward with the palms together. A strong rope, like sash-cord, is looped upon the wrist, then wound tightly round both arms to the elbows, cutting deep into the flesh and tending to break the elbow joints. This was regarded more terrible than the thumb stocks. This was the Bohemian method; but another form was prescribed for Austria equally effective and ingenious.

The famous rack, which comprised the third grade, was of great utility in the "discovery of the truth." It was called *equuleus*, or little horse, by the Austrian as well as the Roman jurists. Four full-page engravings depict the exact form, size, mechani-

cal construction, and practical use of this machine. It is a wide ladder of two strong poles with many rounds, and is fixed in a slanting position from the stone floor to the dungeon wall. The culprit must climb to the upper part and sit down; his wrists, previously bound behind his back, are tied to the fifth round. His feet are bound with a rope, which is drawn down by a windlass attached to the base of the ladder. As he is pulled downward his arms are twisted upward behind him. When fully carried out the desired result was complete dislocation of the shoulders, as the explanatory notes declare with great exactness of detail.

The *Scharfrichter* must stand on the rack beside the *Inquisit*, keeping one hand on the breast and one on the back to watch his vital condition; as his accusations are persistently denied, he signals to the windlass-man to apply more force, till at last the arms are wrenched into a straight line with the body, tearing the ligaments and breast muscles from their attachments. Then, if the martyr is a hero who can endure still more without denying his faith, the judge may proceed to the fourth grade, if in Bohemia, though it was forbidden in Austria.

The final grade, *ignis*, or burning, is figured by several cuts, showing torches of candles bound together, eight in each torch, lighted and burning brightly, which the tormentor, bending over his broken victim, applies to the naked sides of the chest until a space about seven inches in diameter is burned to a blackened crisp. The law strictly forbids burning a larger space, or any other region of the body; but it allows the assistants to aggravate the anguish of suspension and of racking by beating with scourges.

These four grades are extended by equivalent tortures of other forms, such as the *Spanische Stiefel*, or iron boots. Two broad iron plates, curved to fit the shin and calf and extending between the knee and ankle, are connected by screw bolts at the margin to compress them together. The inner surface of each is studded by thirty blunt nails, half an inch long, to be forced into the flesh and bones. To increase the pain in special cases these plates may be hammered upon. One of the most realistic engravings shows a group of inquisitors applying this boot to an old man, who seems visibly shrieking for relief by death.

Yet there was one heinous sin for which torture had no terrors. Suicide had need of a different chapter in our book of justice. When some poor hunted soul had broken the jail of the body, driven from the certain cruelties of this life to the imagined terrors of the next, the torturers were exasperated and disappointed; yet something must be done to relieve their brutal fury, just as the mob of to-day invariably "riddles with bullets" the corpse of its victim. The chapter on suicide proclaims the great

double sin of the deceased, denies him respectable burial (*honesta sepultus*), and dooms the poor remains to dog-burial (*canina sepultus*) at some cross-roads, with or without a stake driven through. It then proceeds to render his family infamous by attainder and to impoverish his heirs by confiscation of all their property. There being nothing left to destroy, Theresa's code here suspends hostilities against the suicide.

In the gradation of crimes, blasphemy was held infinitely worse than all others; while second in enormity was apostasy from the ruling faith. This is carefully limited to those who have been within the fold and have backslidden, thus excluding the different offense of heresy. The omission of heresy from the book shows that it fell within the special province of ecclesiastical courts, or else that there was a glimmering of spiritual toleration in those days.

The third great class of crimes, transcending in awfulness treason, murder, and all that follow, comprised the imaginary delusions called magic, witchcraft, and sorcery. There is an extreme effort made in this chapter by the solemn wise men of 1769 to be very judicious, calm, and reasonable. A full translation of this treatise on the ghastly joke called witchcraft, would form an exquisite satire on the self-complacent wisdom of that or any other age. It enjoins on judges great care to avoid the errors and foolish superstitions of the ignorant lower classes, and warns them never to convict, except upon positive proof that the accused is a genuine witch or sorcerer. It argues and establishes the actual existence of the black art, the evil eye, and possession by devils. Then it sets all the wheels and screws of torture at work against "all those God-forgetting wretches who commune with the devil, raise great storms, bring about cattle-plagues, or go sailing through the sky upon a goat."

The forty-odd other classes of crimes follow in descending order, each having a little chapter containing its special code and commentary, with the following usual subdivisions:

Definition and general principles of the offense.

Different gradations of its enormity.

Amount and character of evidence necessary for issuing the warrant and arresting the suspect.

Evidence requisite to show probability of guilt and justify use of torture on trial to secure confession.

List of special interrogatories for each crime, to be used before and during torture.

General and special directions to the magistrate for unusual cases.

List of possible circumstances tending to aggravate the offense and calling for additional severity.

List of possible mitigating circumstances under which prosecution may be relaxed and penalties reduced.

Scale of punishments for different grades, and forms to be used in pronouncing sentence, after torture and conviction.

The irrepressible savage love of causing pain was shown by the methods of execution as well as those of examination and trial. A translation of the prescribed forms of final judgment exhibits a tediously elaborate array of fiendish methods to make death slow and agonizing, and strike terror into myriads of beholders. Though foreign to our present topic, they illustrate the ruling passion of that age.

The chapter on allowing the accused the privilege of attorney and defense, begins with the fine assertion that defense is to be denied to no one. Then comes an intricate list of conditions and exceptions, which narrows the privilege to a very small chance. The final condition, however, might well be adopted for the reform of modern courts: "Before the *defensor* takes up the case of a prisoner, he shall bind himself not to act dishonestly to suppress the truth, but to do everything *in bona fide*."

To determine guilt or innocence, the ancients—that is, savage races in general—have used all sorts of divination, more or less senseless or cunning. There were water tests, fire tests, poison tests, and exposure to wild beasts. One favorite fashion was by single combat, which has degenerated into the modern duel. The wager of battle, like all the rest, presumed the idea that the Deity would interfere to protect the guiltless. Races sprung from Viking stock were especially liable to this error, which even to-day is firmly rooted in the minds of whole nations when pugnaciously disposed.

In trying to account for judicial torture, some have held it a sequel and substitute for the wager of battle, showing a moral advance of ideas in the growth of the nation. But this theory hardly fits with the great antiquity and wide extent of the system. If torture was a sequel of the judicial duel, then it was a case of retrograde evolution; for the high moral features of the combat, such as faith in divine help, trust in a just cause, fair play, and championship of the innocent, were thrown aside. They were exchanged for a system of mean, cowardly cruelty, all the power of the rulers working out hatred upon one defenseless prisoner in the secrecy and safety of a dungeon vault.

It is also idle to claim that torture was based on that sophism credited to Jesuits of old, that it was lawful to do evil to attain a good result; for torture was ancient before Loyola began his work. On the other hand, it is idle to make the common assertion that all progress, conscience, and mercy were conferred on the world by some particular religious system or event. For it

was such a system which maintained the tortures portrayed in the Theresian code, and which, during centuries of supreme control, had sole power to remove the curse, yet never took a step in that direction till driven by outside pressure.

There is a great work to be written by some student who can relate the decline and fall of that engine of tyranny. Many nations successively were freed from its terrors. It was a long and bitter war between the allied powers of kings and priests, and the true lovers of humanity. It was a secret war of ideas, and its weapons were the clandestine publications of daring freethinkers, secretly translated and circulated over Europe at the risk of a lingering death in the torture chamber.

Such a work would be a history full of joyous reading. One would fain learn everything about Beccaria, the first and greatest successful mover in that holy cause. We would confer all due honor upon Hommel, Voltaire, Howard, and those who helped spread the great Italian's burning words over the continent. Our copy of Theresa's code was printed five years after Beccaria had issued his great work for the abolition of capital punishment and torture. The conflict of the age had begun, but the great empress knew or heeded it not.

The old system left its marks on our language. Persistent questioning is called "inquisitive," and when one's acts are put under sharp inquiry they are "called in question." People who do not know what the rack was, complain of racking pains. Ladies "suffer excruciatingly," without thinking of the myriads who have really been excruciated, or put to death on the cross. The word *torquere*, applied by the Latins to the twisting of human limbs, gave us such words as torture, torment, and extortion. Ladies may now be called "bewitching" without being accused of actual dealings with Satan. In short, words once of deadly import are now the weakest of hyperbole.

Since these reforms of ancient abuses became universal, their ideas have been extended in America to an unwise and absurd degree. Sentimental mercy has not only destroyed the efficiency of courts of justice, but has impaired national confidence in them. A second reaction takes place, from the false mercy of maudlin sympathy with crime, to the deliberate and lawless fury of mobs and lynchers. The prevention of cruelty to animals is an absorbing "fad" with some who would not concern themselves with the heart-breaking tyranny of a drunken husband in the nearest house.

Yet evolution works steadily on. Whether it be a hundred years hence or a million, the day may come when every mortal in his strength and pride will be too noble to torment the weak or helpless.

CUSTOMS AND SUPERSTITIONS OF THE MAYAS.

BY MRS. A. D. LE PLONGEON.

FROM ancient Maya books and inscriptions we learn that the Mayas at one time formed a great nation, occupying the territory between Tehuantepec and Darien. To-day those Indians, as they are called, live in the peninsula of Yucatan, famous for its ruins; in Guatemala, in Peten, in the Lancandon country, on the banks of the Uzumacinta River, and in the valleys between those mountains where the mysterious "land of war" is supposed to be.

Among all people, civilized and uncivilized, superstition exists, though the former are more careful to conceal their peculiar notions. The Mayas are more superstitious now than they were

INDIANS BLASTING ROCKS TO LEVEL A ROAD.

five hundred years ago, for, added to their own queer notions, they have a vast store of strange fancies imported by the Spanish conquerors. Many of the native ideas are of great antiquity, such as the belief in metempsychosis and metamorphosis. Those people hesitate before killing the most venomous reptile, if found in or near the old palaces and temples left by their ancestors, and now gradually crumbling beneath the dense foliage of tropical forests. Urge them to destroy a viper within or near those deserted halls, and they say: "Ah, no! it belongs to the *Xlab-pak yum*" (lord of the old walls), "whose spirit roams here." Under such circumstances they recoil from inflicting death, much as

they would if told to murder their father or mother—a thing unheard of among them, for they revere and honor their parents above all others. To their elders they show much respect, never presuming to contradict them beyond remarking, if they do not agree with what is said, "So says my elder," implying that but for that they would express an opinion.

When questioned about the old ruined cities, they reply, "The dwarfs built them," and insist that the *pixan*, or souls of those dwarfs, always walk about at night, coming into their houses, though the doors be shut. In the daytime they are supposed to dwell among the ruins. The reputation of the *alux* (dwarfs) is not much better than that enjoyed by the "little people" of Ireland and Scotland, accused of stealing butter, souring milk, and changing pretty babies for ugly little creatures with wrinkled faces. The *alux* are said to disturb tired laborers by shaking their hammocks, lash those who slumber too heavily, throw stones, and whistle. They terrify all who look at them, and steal food;

School of Mestizas Girls at Hoctam.

for, though not taller than a child four years old, they can eat more than any man does. Their only article of apparel is a very wide brimmed straw hat.

Belief in these dwarfish apparitions is perhaps induced by a vague knowledge that several centuries ago a race of remarkably small people did live in those parts. Edifices built by them are found on the east coast of Yucatan and on adjacent islands. There are several temples only nine feet high, and triumphal arches of

the same height, while the doorways are but three feet high and eighteen inches wide. In some of those houses domestic utensils have been found, very small. Any traveler may examine the strange little houses; and doubtless the belief in the phantom

SOUTHEAST CORNER OF NORTH WING OF CAN'S PALACE, UXMAL.

alux is an outgrowth of tradition concerning the dwarfish people who constructed them.

Directly opposed to the *alux* is *Huahuapach*, a gigantic specter supposed to put himself in the way of belated travelers and make them fall so as to injure themselves. This, again, would be some dim recollection of those big men whose bones have at various times been unearthed in different parts of the peninsula. Several historians testify to such gigantic remains having been dug from the ground in the early part of the Conquest. We have also been assured by people of Spanish descent, now living in that country, that they themselves have disinterred enormous skulls and other bones of the human body. None had the curiosity to keep them. To this may be added that on the walls of certain ancient structures there are imprints, eleven inches long, of hands that had been dipped in red liquid and pressed upon the stones, as it was customary for the owner of the building to do.

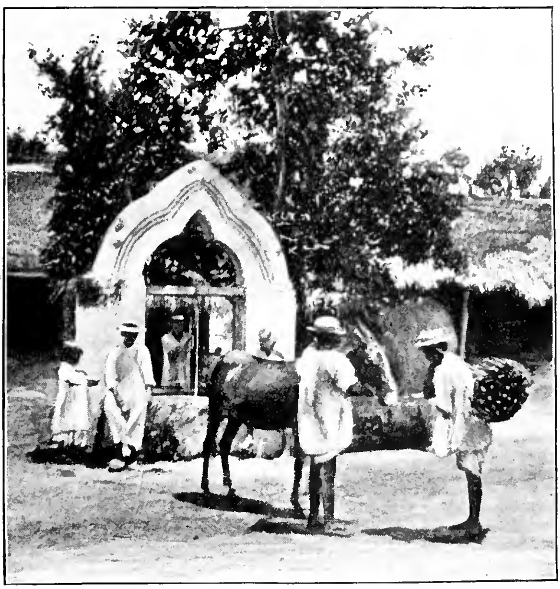
Xtabai is a wicked, deceitful phantom, said to haunt the highways at night. It appears as a beautiful woman, always combing her luxuriant locks with a plant that the natives call "the comb of *Xtabai*." This lovely being generally runs away when any one approaches, but, if a lovesick laddie does succeed in clasping her in his arms, she instantly transforms herself into a sack of thorns that rests on two duck's feet. After embracing this prickly arrangement the deluded youth is ill with fever.

Another much-dreaded nocturnal, unsubstantial individual is *Balam*, god of agriculture, an old fellow with a long beard, said to walk in the air and whistle as he goes. Should his people fail to make offerings to him, he would vent his spleen by afflicting them with sickness; therefore, the first fruits of the field are for him. The corn first ripe is scattered upon the ground, and pies, the crust made of corn, are also prepared for the god to enjoy at his leisure. These pies are seasoned with enough red pepper to torment the palate of any number of balams (leopards). One pie is put in each corner of the field, three being sprinkled with a liquor called *balché*. The fourth is left without this sauce, possibly for the benefit of any teetotaler friend who may happen to call.

Balché is a liquor made by soaking the bark of a tree thus named in a mixture of honey and water. When fermented and kept some time it is very intoxicating. The Indians use it in all their ancient rites and ceremonies, and the Fans of equatorial Africa make liquor in the same way.

Catholics in name, the Mayas in fact prefer to render homage to any stone figure that once ornamented the temples of their forefathers. We have seen one, kept in a cavern underground, that served as a personification of Balam, for it represented a man with a long beard, and to it they make offerings of corn. As a work of art the figure is worthy of notice. Its antiquity can not be doubted, similar ones being sculptured on pillars at the entrance of a very ancient castle in the famous ruined city of Chichen. The figure in the cavern is on its knees; its hands are raised to a level with the head, palms upturned. On its back is a bag containing a cake of corn and beans, the whole cut from one block of stone. This statue is now black, owing to the incense and candles with which its devotees smoke it. Previous to sowing grain they place before it a basin of cool beverage made of corn, also lighted wax candles and sweet-smelling copal, imploring the god to grant them an abundant harvest. When the crops ripen the finest ears are carried to the smoke-begrimed divinity by men, women, and children, who within the cavern dance and pray all day long, some of their quaint instruments serving as accompaniment to the Christian litanies which they chant without having the vaguest idea of their meaning.

An instrument that they use in their religious practices is the *tunkul.* The literal meaning of this word is "to be worshiping." The tunkul is a piece of wood three feet long and one in diameter, hollowed out. On one side it has a mouth extending nearly from end to end; on the other are two oblong tongues starting from the extremities and separated in the middle only by the thickness of a carpenter's saw. Its mouth is placed in contact with the ground, and the tongues, serving as two keys, are struck with sticks whose ends are covered with India rubber, which makes them rebound. The tones thus produced can be heard five or six miles off, when the wind is favorable, and sound like a great rumbling in the earth. The same instrument was used in Mexico.



A Well by the Wayside.

In the museum of the capital of that republic some finely sculptured tunkuls are preserved.

The Maya Indians take a great deal of pleasure in ceremonies and religious observances; religion is a very important matter with them, though it is doubtful if they could tell exactly what they believe. They punctually attend church, but their worship is in reality an odd mixture of paganism and Christianity. Being fond of sweet things, and by nature indolent, their idea of heaven is a place where they will rest beneath the spreading branches of an evergreen tree and enjoy an inexhaustible supply of sweet things; while hell is a region where they will suffer intensely from cold, fatigue, and hunger. Nor do they hope to escape that

torment, for it is their belief that when death claims them they will be conducted to the gloomy abode to suffer for all the wrong they have done, after which they will be in heaven for a time as a recompense for their good deeds; that then—some ages having elapsed—they must be reborn on this earth, without any recollection of the past or knowledge of the future.

When one is dangerously ill, his relations make offerings to the *yumcimil*, or "god of death." This offering consists of food

A Tunkul.

and drink, which they hang outside of the house. They call it *kex*, or "exchange," because they offer it as a ransom for the life of the patient.

From remote times they have been accustomed to make offerings to the souls of the departed, particularly a certain pie that they call "food for the soul." The crust must be of yellow corn; the interior, tender chicken and small pieces of pork. These pies are wrapped in leaves of the banana tree and baked underground between hot stones. When done, they are placed on the graves or hung from trees close by. Sometimes, after leaving them there for an hour or two, the living take home the pies and enjoy them,

saying that the souls have already drawn from them all the ethereal part of the substance.

When among the ruins in the ancient city of Chichen Itza, we happened to be very hard pressed for food on All Saints day, as on many other occasions, and knowing that the "feast of the dead" would be celebrated in a not very distant village, we allowed some of our men to go there and take their chance of enjoying a good meal.

In that they were most successful, the natives being at all times exceedingly hospitable, and never failing to invite those who approach their home to partake of what they have. But the men also thought of us. We had early taken to our hammocks, remembering the saying, "*Qui dort, dîne*" (He who sleeps, eats). About two o'clock in the morning we were aroused by a man only just returned from the village. He had waited there till all were asleep, then made his way to the graveyard, and gathered from a tree a fine fruit in the shape of a large pie. This he brought to us, wisely arguing that the embodied needed it more than the disembodied. The dead man's food was still wrapped in its banana leaf, and we were not sorry to avail ourselves of this chance to breakfast at two o'clock in the morning. No tender chicken was concealed within that particular crust, only a pig's foot with a few stray bristles on it, and a most liberal dose of red pepper, but hunger made it excellent.

When overtaken by disease, the Indians doctor themselves with certain herbs, and if that fails, call a medicine man, who knows about as much of their malady as they themselves do—perhaps less. They never attribute illness to natural causes, but either declare that they are bewitched or that their time has come and Death wants them. The medicine man pretends that he can discover the party who has done the bewitching, and for that purpose demands three days' meditation in the home of the patient, during which time he must be supplied with all the good food and drink procurable. On the third day he drinks balché, nectar of the gods, until he falls into a heavy sleep. The instant he awakes he looks into a crystal and there pretends to see the witch or wizard. He then scrapes the mud floor under the hammock of the patient, and produces a small figure that he, of course, had concealed about his person, and declares that that was what caused the sickness. For this simple trick he receives a fee. If the patient recovers, the medicine man's reputation is greatly increased. If death results, the mourners say: "It is very hard, but so it was written; his time had come; it had to be thus."

The little figures used by the trickster are made of wax and have a thorn stuck in the part corresponding to the seat of greatest pain in the body of the victim. This particular superstition

may therefore have been introduced by the Spaniards, for at one time *l'envoûtement* was believed in nearly all over Europe; even yet credence is given to it among voodoo societies in Louisiana. *L'envoûtement* consists in pricking and slowly melting a small wax figure representing the individual intended for a victim of magic art. Charles IX, of France, was said to have come to his

Indian Women spinning.

death by means of wax figures made to his likeness and cursed by magic art which his enemies, the Protestant sorcerers, caused to melt, a little every day, thus extinguishing the life of the king by degrees as the figures were consumed.

That same monarch is said to have expelled thirty thousand sorcerers from the city of Paris; and during the reign of Henry III, France was supposed to be infested with one hundred thousand individuals who practiced the black art. Physicians in those days made the sorcerers responsible for all diseases that they failed to cure. Consumptives especially were supposed to waste away as the wax figures did when melted.

In former times the Indians used to abandon a house after one died in it, because they buried the body either in the house or at the back of it, and were very much afraid of seeing the ghost of the dear departed. Strange creatures, to weep so much at losing them, and then be terrified at the thought of their returning!

They believed that the lower animals also had souls, for they used to put with the corpse of their relations certain provisions

which they said was to feed the souls of the animals they had eaten during life, so that these might not harm them.

They bred a species of dog, quite hairless, called *tzom*, considered a great delicacy. They killed them by choking them in a pit, and this seems to have weighed heavily on their conscience, for they were particularly careful to provide deceased relations with food to pacify the slaughtered *tzoms*.

Being constant and careful observers of Nature, and seeing the remarkable works of many creatures, they attribute intelligence to small insects, such as the ants and bees. In some parts of England it is supposed that bees will not remain on the premises after there is a death in the house of their owner, unless an intimation of the fact be conveyed to them. Therefore some go and tell the bees; others tie a piece of crape to a stick, and set it in front of the hives.

The Indians in question would not tie crape near their hives, for they themselves never use any kind of mourning, retaining always their white garments. They suspend from the hives gourds filled with a beverage made from corn, in order that the bees may not go away, but produce abundant honey and keep sickness from the home. The hives are not like those in use among us, but simply pieces of trunk hollowed out, wooden walls being fitted into the ends and covered with mud so that the name

A Yucatan Village.

of the owner may be stamped on it with white ashes. A small hole is left in the middle of each end for the passage of the bees. If the hives are not cleaned from time to time, the bees desert them. In order to do this, the operator removes the end walls, cleans the interior thoroughly, and rubs it with a little honey and an aromatic plant that is much liked by the bees. Unlike our bees, these are quite harmless, black and small, though they mani-

fest their annoyance when intruded upon, by swarming about ones head, getting into hair, ears, eyes, and nose. After their hives are cleaned they make no mistake as to their homes, every insect returning with unerring precision to its own quarters. At each entrance a bee sentinel constantly stands, to give warning of approaching danger, when, from within, the door is immediately blockaded.

We must not forget to mention the *Ez*, the genuine wizard, supposed to call to his aid the black art for evil purposes, whereas the medicine man is believed to be a good magician. The *Ez* may and does "bewitch" those who offend him, but the medicine man can break the spell. They are very careful to make this distinction between magician and sorcerer.

While in the eastern part of Yucatan, we frequently heard people speak of the Jew's Book, a medical work bearing that title. At last it fell into our hands—not a printed copy, though it has been put in type, but the old Spanish manuscript. The contents rather astonished us. As a cure for leprosy, patients are advised to drink the water in which an unplucked turkey buzzard has been boiled for three hours!

However, we found some very important recipes. Here, for instance, is one to cure the bewitched: "First take a root of vervain, cook it in wine and make the patient drink it. This will be thrown up. To know if the person is bewitched, pass over him a branch of the plant called *skunk*. If the leaves turn purple, the patient is bewitched. To free him from the enchantment, let him wear a cross made from the root of the skunk plant." The odor of that plant would most undoubtedly remove all charm from any person!

Side by side with those absurd prescriptions, there are others quite in accordance with the *materia medica*. The book is believed to have been written by a white man, and many white people and half-breeds have the greatest confidence in it. As for the Indians, they summon the medicine man to give them herbs and dispel the evil power of the wizard that has prostrated them.

The work in chemistry of 1893 is described by Prof. J. E. Reynolds as having been substantial in character, though almost unmarked by discoveries of popular interest. Among its features are Moissan's artificial production of the diamond; the studies of Dr. Perkins on electro-magnetic rotation, of Lord Rayleigh on the relative densities of gases, of Dewar on chemical resistance at extremely low temperatures, and of Clowes on exact measurements of flame-cap indications. Horace Brown and Morris, studying the physiology of leaves, have led to novel conclusions respecting the formation of cane sugar and of starch; and Cross, Bevan, and Beadle have added to our knowledge of members of the group of celluloses.

BIOLOGY AND ETHICS.*

By Sir JAMES CRICHTON BROWNE, M. D., F. R. S.

IN the case of civilized man natural selection is subject to numerous and extensive limitations. The struggle for existence still goes on vehemently enough; but it is changed in character, and instead of animal rapine we have industrial competition. The brutal and relentless acts of self-assertion that in a savage state secured the survival of the fittest—that is to say, of those best adapted to savage surroundings—have been condemned as unsuitable to a more artificial existence and are punished as crimes, and the conflict is carried on by cunning devices which abolish the weakest slowly and unobtrusively and do not outrage certain moral feelings opposed to violence which have in the meantime grown up. But, more than that, in social progress the struggle for existence becomes in certain directions a surrender not of the feeblest but of the strongest and the best. A recognition of the obligations which man owes to his fellow-men and the promptings of "Love's divine self-abnegation" impose restraints on some of the competitors who, instead of forcing their way to the front, as they are well able to do, stand aside and allow themselves to be beaten by those less fitted to survive. To adapt the illustrations of Malthus, Nature still spreads her feast for twenty guests, while thirty stand by ready to partake of it, but, whereas in primitive times the twenty strongest would have unhesitatingly appropriated the sustenance, in these more virtuous days fifteen of the strongest and five of the weakest secure it, because five of the strongest have chosen to abrogate their natural claims. The census returns clearly show that while the age of marriage in this country steadily rises among the educated and affluent classes, it remains painfully low in agricultural districts and in the poorer quarters of the great towns.

The interference with the struggle for existence which civilization and ethical development involve is familiar to medical men above all others, for their professional career is one sustained endeavor to prevent the extermination of the unfittest and, therefore, to check the operation of natural selection. It is theirs to succor the victims who have been smitten in the fight, and who, but for their aid, would perish; it is theirs to preserve weakly lives which left unprotected would be ruthlessly stamped out; it is theirs to circumvent conquering bacteria and so prevent mortality and swell the millions contending for a bare sub-

* From an address delivered at the opening of the session of the Sheffield School of Medicine at Firth College, Sheffield, on October 2, 1893, and printed in the London Lancet.

sistence; it is theirs, as the chosen ministers of the higher ethics, on the one hand, to counteract the life-destroying checks which operate chiefly on the feeble and incompetent, and, on the other, to inculcate the prudential considerations which are most influential with the finest types of mankind. No doubt the wider scope which modern science has given to medical practice enables those who pursue it to render services to the strong as well as to the weak, and to compensate in some degree for the general lowering of vitality which the maintenance of sickly lives tends to produce. Sanitary improvements and the removal of many of the causes of disease not only keep the infirm alive but insure increased vigor to the constitutions of the robust. But still the result of medical work as a whole at the present time must tend toward the intensification and the thwarting of the struggle for existence and perhaps to some deterioration of the species, for medical work does intermeddle with Nature's rough and ready methods in selecting her breeders. Great numbers of weakly infants who would formerly have perished in their infancy are now reared to a weakly maturity and enabled to propagate their weakliness (for the weakly are often highly prolific), while they take part in the life battle on terms sometimes made unduly favorable to them by the commiseration that their weakliness commands; and this fact ought not to be lost sight of when we are congratulating ourselves on our greatly diminished death-rate. An enormous saving of life has been effected, but mainly in life's earlier decades. The death-rate is actually increasing among males at all ages above thirty-five and among females at all ages above forty-five; and it is not difficult to prove that this increased mortality at post-meridian ages is due partly to the enhanced wear and tear of modern existence and partly to the survival of weakly lives artificially protected and prolonged.

The origin of those moral sentiments which, in the case of our race, are modifying the course of natural selection and which have evoked and molded the profession to which we belong is as inscrutable as the invention of natural selection itself, but their development has some light thrown on certain of its stages by biological considerations. In the life history of living organisms we can trace out some rudimentary phases of a new struggle for existence, a struggle between ethical principles and animal propensities, a struggle that has to be fought out in the brain and mind of man, but that is foreshadowed in paltry protoplasmic particles. For very early in organization may ethical rudiments be detected; indeed, the moment we get beyond the solitary cell, a simple organism which merely feeds and grows and liberates superfluous parts of its substance to start new organisms like itself, mutual obligation or what might be called a moral relation

is discernible; antagonism is converted into co-operation and conflict gives place to harmony, and the higher we ascend in the scale of being the more far-reaching and complicated does co-operation become. Individualism is gradually subordinated to collectivism, and the struggle for existence becomes mainly the concern of the organism as a whole and is only in a minor degree that of the units of which it is composed. Growth, form, and structure are regulated by an organic process only very slightly modified by external conditions and not at all by the selection of the fittest among the growing, formative, and tissue-making parts. "In each of these complicated structures," says Huxley, in referring to the roots, stems, leaves, flowers, and fruit of a bean, "as in their smallest constituents, there is an immanent energy which in harmony with that resident in all the others incessantly works toward the maintenance of the whole and the efficient performance of the part it has to play in the economy of Nature." In a higher animal we have untold millions of cells of widely different constitution and habits, not merely dwelling together in amity but co-operating for the good of the system in which they are incorporated and undergoing harmonious and efficacious metamorphoses as it unfolds. The system is still engaged in the struggle for existence, but its constituents can not in any true sense be said to be so on their own account. Their self-assertion is limited by the organic process, or what would at one time have been called the law of design, the equilibrium and comity of tissues being secured by a self-restraint that is inherent in them, that was inherent in the vital impulse that called them into being, a restraint on the nutrition and reproduction of each to secure the nutrition and reproduction of all, a restraint that when from any cause it is broken down leads to disease, as in the overgrowth of cancer. And, as in the case of the cell, so in that of the animal, the moment we get beyond the solitary animal fighting for its own life, mutual obligation or consensus becomes apparent, for if two animals combine to fight together there must be a tacit understanding that they are to forbear from fighting each other while so engaged. In all associations of animals the association which is useful to them in their struggle for existence is only maintained by some curtailment of the self-assertion that is of the very essence of the struggle. Sheer animalism is to some extent restained, antagonism for certain purposes is merged in co-operation, and individualism is modified in its manifestations by self-denial. In the ant-hill and beehive and among all state-forming insects may be observed an orderly polity involving the co-operation of different classes which exist not for their own advantage but because they are of value to the state and have given it a superiority over differently constituted colonies, and in

all packs, herds, and communities of animals there is some subordination of self-will to secure the realization of the universal will in social existence. And the higher we ascend in the scale of gregariousness the more conspicuous does co-operation become, until among the higher races of civilized man we find that it has in some degree transferred the pressure of the struggle for existence from the individual to the body corporate, and that it tends to do so more and more. Social organization is loose and shadowy when compared with that of living beings, and differentiation of structure and function in it are partial and ill-defined, but still it is readily perceived that its development is regulated by a social process which, although it may seem to emerge from environment and the struggle for life, clearly implies as it goes on not only the harmonious coexistence of different classes differently employed and interested in a larger life than their own, that of the system or nation of which they form a part, but the subjection of individual self-assertion to social growth, in accordance with some social ideal or, shall we say, design. In the social not less than in the organic process we see pause given to the life struggle and the co-operation of diverse parts to a common end. In highly civilized societies certain classes—propertied and pensioned classes—are practically relieved from the struggle for existence by the operation of moral restraints, and it is the avowed aim of state socialism to make that struggle less and less the concern of the individual and more and more that of the state. In the intercourse between nation and nation traces of co-operation may be recognized.

But it is in sexual relations far more than in the organic or social process that the embryonic forms and cotyledons of the moral sentiments that among mankind, when in full leaf and blossom, mask and overshadow and sometimes choke natural selection may be most clearly recognized. Nutrition is everywhere egotistic, but reproduction is invariably altruistic in its character. In its lowest form, where two exhausted cells flow together, reproduction corresponds with what has been designated protoplasmic hunger; but wherever true sexual union takes place we have activities that are other, regarding and whenever genuine maternity is differentiated we have hints of self-sacrifice. Sexual preferences and the selection of mates have obvious reference to the continuance of the species and the welfare of the offspring and imply co-operation, and the fatality that attends the triumph of motherhood represents the immolation of the individual for the collective advantage. Among the insects we have the pairing of mates preceded by courtship and followed by associated industry, as in the *aterechus*, where the male and female beetle disinterestedly toil together in rolling up receptacles for their unborn off-

spring, and throughout the whole animal kingdom, from the *mesozoa*, where the female dies in giving birth to her ova, upward, we have illustrations of the sacrificial nature of the reproductive process. Rooted in physical wants and sensation, the reproductive impulse and parental instincts are gradually reenforced by psychical sympathies and branch into altruistic manifestations. The fierce fight of the stickleback with his rivals and his jealous guardianship of the nest to which he has conducted his bride may be but expressions of blind instinct, and the brooding of the hen on her eggs may be a mere indulgence in an agreeable siesta, but it is impossible to doubt that in the action of the walrus or tiger in desperately defending its young, even when wounded and suffering, and at the expense of its own life, there is an element of disinterested love. Such maternal devotion evinces not reckless self-assertion and the desire to hunt down competitors, but the antithesis of these: self-abandonment and care for others. Between the mother and her offspring there is no struggle for existence, but there are alliance, affection, and co-operation.

In the pairing of mates, then, in their copartnership often extending far beyond the breeding season, in the provision made for offspring, in the care and training bestowed on them after birth, and in the establishment of family groups, all reproductive phenomena, we have in the animal series the analogues, minute but distinctive, of the altruistic emotions which in human beings, fostered and transmuted by various agencies, have enabled them as regards certain relationships to struggle out of the dismal swamp of the "struggle for existence." And in the case of human beings it has, I believe, been the formation of distinct family groups that has more than any other reproductive influence been contributory to moral progress. The family is the social unit, the nursery of goodness, the school of character, the germ-plasm of the loftiest virtues, for it is by a diffusion of the feelings that well up within its precincts to the clan, the nation, and the race that we become public-spirited, patriotic, and philanthropic. The savage owes to it his first glimmerings of ethics, and we in this country owe to it the prosperity we enjoy. Its associated life necessitates a curtailment of self-assertion, a discipline of self-will, and is incompatible with irresponsible atomism, but favors the evolution in due sequence of the dispositions that fit for companionship under civilized conditions.

Now we have been told lately that the family is played out and doomed. Mr. Pearson, in his remarkable and able work, has argued that it will ultimately, to a great extent, be merged in the nation. He looks forward to a state of things in which there will be a weakening of the marriage bond, wedlock being, instead of a union for life, a partnership during good behavior or pleasure,

and in which children growing up, better educated than father or mother, will know that they have to thank the state for schooling and protection and are little indebted to their parents, who have simply taken advantage of their tender years to confiscate the proceeds of their industry. In these halcyon days there will be a state *crèche*, a state school and state medical institution, supplemented by state meals, and the child when well drilled in the state gymnasium will pass from the state school into a state workshop, and finally on to the state crematorium. The result of all this will be that as marriage becomes legalized concubinage the obligation of family duties will attenuate; as children understand that it is to the state they have been indebted for maintenance the old feelings of gratitude and affection which bound them to their parents will dwindle away; and as parents lose their proprietary and administrative rights over children they will more and more shift the responsibility for them on to the state. The family with all its sacred traditions and precious training will decline, and man—like the cuckoo—will be constantly seeking to foist on others the maintenance of his offspring. Mr. Pearson's prognostications, however, are, I venture to think, of an unnecessarily gloomy description. They are founded on the assumption that society is destined to become more and more secular; they betray ignorance of human nature, for surely the love of children for parents is not founded solely on a sordid calculation of what they owe them; and they involve the error that the volume of feeling must always be the same and that its expansion in one direction, so as to embrace the sphere of state action, implies its contraction in another direction, so as to exclude family ties and claims. But there is no reason to doubt that reverence for the state may grow without supplanting reverence for the family; nay, there is reason to hope that parental and filial affection will become stronger and more tenacious as time goes on. The restrictions placed by the state, as the exponent of enlightened opinion and sentiment, on the autocratic powers which the head of the family at one time possessed—the very existence of which provoked antagonism and the arbitrary exercise of which corrupted—may be expected to soften and cement the family relationship and make it more complete and lasting than it has hitherto been. Then it is to be remembered that the period of dependence of offspring on parents steadily increases as evolution advances. The higher the animal the longer the duration of this period of dependence. It is more protracted in civilized than in savage races and now than it has been heretofore. And this protraction of intimate intercourse and reciprocal relations between the members of a family certainly means a deepening of the sense of kinship. We may flatter ourselves

with the hope, then, that the tender and, indeed, sacred feelings which have been nurtured in household association will retain their dominion over us, and that the family will survive in unimpaired integrity, the fountain head of altruistic emotions, the palladium of sound morality.

THE ACTION OF MASSAGE UPON THE MUSCLES.

By DOUGLAS GRAHAM, M. D.

THAT "science follows art with limping strides," as so well expressed by an able physician, is perhaps nowhere oftener seen than in the various branches of the practice of medicine. Experience has taught us from time immemorial the value of massage as a nerve and muscle tonic, and, like all good things, the possibility of its overuse. But the recent experiments of Prof. Arnaldo Maggiora, of the University of Turin, so clearly and beautifully detailed in the *Archives Italiennes de Biologie* (tome xii, page 225), have demonstrated that this matter can be brought into the sunny light of exact science and away from the somber shades of quackery, where it has been so long relegated by the vast majority of the medical profession. Zabludowski, it is true, had in part prepared the way for this by showing that when after fatigue from a definite amount of work a rest of fifteen minutes was insufficient to restore the tired muscles to their former vigor, after massage for five minutes they were capable of doing as much work as before, and after massage for fifteen minutes they could do twice as much work as at first.

Prof. Maggiora endeavored to ascertain:

1. The action of massage upon muscles in a state of repose. For this purpose the fatigue curves of the right and left middle fingers in maximum voluntary flexion every two seconds with a weight of three kilogrammes (6·6 pounds) were taken at 8 and 11 A. M., at 2 and 5 P. M., and the following day the fatigue curves of the same muscles with the same weight and rhythm were taken after mixed massage (friction, percussion, and kneading) for three minutes at the same hours of the day. The average result showed that the muscles did almost twice as much work after massage as they did before. The average of the work without massage was 4·252 kilogrammes for the left middle finger, but after massage of the finger and forearm the average was 8·019 kilogrammes before extreme fatigue stopped further contractions. An analogous series of experiments was next made in which the electrical current was employed to tire the muscles by applying it directly to them, and also to the median nerve. The results without and with massage

were similar to the first series, and showed that it takes much longer to fatigue the muscles by contraction from electrical irritation after massage than before.*

2. The next series of experiments were undertaken with a view to determine whether the beneficial effects of mixed massage (friction, percussion, and kneading) increased in proportion to the duration of its application. At 8 A. M. the normal fatigue curve was taken, then every two hours and a quarter after this the curve was taken, having been preceded by two, five, ten, and fifteen minutes of massage of the right and left middle fingers and their corresponding muscles in the forearm. Ten fatigue tracings were thus taken, and the result showed that with five minutes of massage all the useful effect that could be produced was obtained. When the massage was continued longer, for ten or fifteen minutes, there were but slight variations in the amount of work above and below that after five minutes. Similar experiments were made in which electricity was used to tire the muscles in place of voluntary flexion, and the same result was obtained.

3. The object of the next series of experiments was to ascertain the effects of the principal maneuvers of massage—friction, percussion, and *pétrissage,* or kneading. The mode of procedure was as before: first, the normal fatigue tracing was taken; then at regular intervals during the day, every two hours, the fatigue curve was inscribed after five minutes of friction or *effleurage,* after five minutes of percussion, after five minutes of *pétrissage,* and finally after five minutes of friction, percussion, and *pétrissage* alternating. The results showed that there was very little difference in the work that could be accomplished after five minutes of friction as compared with five minutes of percussion. But there was a great increase in the number and strength of the contractions after *pétrissage.* The best effect, however, was obtained after the alternations of all three. (It would be interesting to reproduce the tables and tracings if space allowed.) Like results were obtained when the contractions were produced by electricity applied to the median nerve or to the muscles directly, and the friction, percussion, and *pétrissage* employed separately and alternately.

4. The effects of massage upon muscles weakened from various causes were also studied in the same exact manner by Dr. Maggiora. Upon muscles weakened from fasting the effect of massage was to restore them temporarily, so that they gave normal trac-

* I have elsewhere called attention to the fact that after massage muscles give a much more ready, vigorous, and agreeable response to the will and to the faradic current than they do before.—D. G.

ings of fatigue; and the same result was obtained when the electric current in place of the will was used to tire the muscles.

5. As the result of general fatigue, the muscles of the hand were also tried in an indirect manner. Prof. Maggiora, after a walk of ten miles, to which he was not accustomed, took a tracing of the fatigue curves of the right and left middle fingers as before, and found that they were only capable of doing one fourth as much work as when he was rested. After massage for ten minutes they were so much temporarily rested that they did nearly a normal amount of work and gave nearly a normal tracing. The work probably would have been equal to normal had it not been for the superadded fatigue of taking the fatigue tracing half an hour before the massage; for it has been found that the muscles of the middle finger when tired by contractions with three kilogrammes every two seconds require about two hours' rest in order to give normal fatigue tracings every two hours during the day.

6. The effect of massage upon muscles weakened by loss of sleep was also inspected. In muscular fatigue from fasting rest alone does not restore them, and in fatigue from wakefulness nourishment alone affords no appreciable relief. After the loss of a night's sleep the fatigue curve was taken and found to be very small, but after ten minutes of massage it was temporarily restored to a natural curve, which could not be obtained on previous occasions by rest nor by nerve tonics alone.

7. Intense and prolonged intellectual work produces a state of general lassitude. After the final examination of twenty medical students, which lasted for five hours, Prof. Maggiora was much exhausted. He then took a fatigue curve of flexion of the middle fingers of both hands. This was only about one fifth normal. Half an hour later, after ten minutes of massage, the number of contractions was little less than natural, and might have reached natural but for the fatigue induced by the preceding experiment.

8. After a slight attack of fever of ten hours' duration the muscles were weak the whole of the following day, but after massage the aptitude for work was increased so that the contractions of the fingers gave almost a natural tracing of fatigue.

9. The effect of massage upon anæmic muscles was most interesting. Dr. Maggiora demonstrated that anæmia for a short time—from three to five minutes—produces phenomena in muscles similar to fatigue; or, in other words, lessens their vigor and resistance to work. Compression of his brachial artery was made for three minutes, and at the end of this time, while the compression was still maintained, a fatigue tracing was taken and found to be very small, the finger contracting only eleven times. Two hours later the brachial artery was again compressed for three minutes, and at the same time the forearm was subjected to mas-

sage. At the end of three minutes, the anæmia being kept up, another tracing was taken, and the muscles contracted but nine times, when prevented by fatigue from doing more. Massage has, therefore, no effect upon muscles thus rendered so completely anæmic in the way of increasing their capability for work.

This experiment was made with a weight of one kilogramme (2·2 pounds) and contractions every two seconds. It was found that in a natural condition the middle finger could thus contract two hundred and sixty-five times without any fatigue.*

In comparing this last experiment with the preceding ones it is found that the effect of massage consists essentially in re-awakening the phenomena of the local circulation, in bringing to the muscles a greater quantity of material necessary for their contraction, and in removing the retrograde products of muscular work.

Résumé.—1. Massage, when applied upon a muscle in a state of repose, increases its resistance to work and modifies its fatigue curve by retarding the manifestation thereof.

2. The beneficial effect of massage is within certain limits in proportion to the duration of its application. Beyond these limits there is not obtained any further increase in the production of mechanical work.

3. Massage can hinder in muscles the accumulated effects of fatigue proceeding from the effects of work when not sufficient intervals of rest have been allowed.

4. The various manœuvers of massage act with different intensity upon the aptitude of muscles for work. Percussion and friction are inferior to *pétrissage* and to mixed massage.

5. In muscles weakened by fasting we can, by means of massage, notably ameliorate their resistance to work.

6. Upon muscles fatigued or weakened by a cause which acts upon the whole muscular system, such as prolonged walking, loss of sleep, loss of food, excessive intellectual work, etc., massage exerts a restorative influence which brings back to them their power of doing a natural amount of work.

7. The beneficial effects of massage upon the phenomena of muscular work are no longer produced when it is applied upon a muscle in which the circulation of blood has been suppressed.

The potato, according to Mrs. Lily Grove, grows native in the islands of Chiloe, in the wildest districts, even at the top of the highest mountains. A whole region is called after it, and it is often the sole food of the people.

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* In all these experiments the massage was done with the same energy by Prof. Maggiora's assistant, Dr. Grandis. The ergograph of Prof. Mosso was used to take the tracings of the fatigue curves.

THE ICE AGE AND ITS WORK.

By ALFRED R. WALLACE, F. R. S.

ERRATIC BLOCKS AND ICE-SHEETS.

I.

IT is little more than fifty years ago that one of the most potent agents in modifying the surface features of our country was first recognized. Before 1840, when Agassiz accompanied Buckland to Scotland, the Lake District, and Wales, discovering everywhere the same indications of the former presence of glaciers as are to be found so abundantly in Switzerland, no geologist had conceived the possibility of a recent glacial epoch in the temperate portion of the northern hemisphere. From that year, however, a new science came into existence, and it was recognized that only by a careful study of existing glaciers, of the nature of the work they now do, and of the indications of the work they have done in past ages, could we explain many curious phenomena that had hitherto been vaguely regarded as indications of diluvial agency. One of the first fruits of the new science was the conversion of the author of Reliquiæ Diluvianæ—Dr. Buckland, who, having studied the work of glaciers in Switzerland in company with Agassiz, became convinced that numerous phenomena he had observed in this country could only be due to the very same causes. In November, 1840, he read a paper before the Geological Society on the Evidences of Glaciers in Scotland and the North of England, and from that time to the present the study of glaciers and of their work has been systematically pursued with a large amount of success. One after another crude theories have been abandoned, facts have steadily accumulated, and their logical though cautious interpretation has led to a considerable body of well-supported inductions on which the new science is becoming firmly established. Some of the most important and far-reaching of these inductions are, however, still denied by writers who have a wide acquaintance with modern glaciers; and as several works have recently appeared on both sides of the controversy, the time seems appropriate for a popular sketch of the progress of the glacial theory, together with a more detailed discussion of some of the most disputed points as to which it seems to the present writer that sound reasoning is even more required than the further accumulation of facts.*

* The works referred to are: Do Glaciers Excavate? by Prof. T. G. Bonney, F. R. S. (The Geographical Journal, vol. i, No. 6); The Glacial Nightmare and the Flood, by Sir H. H. Howorth, M. P., F. R. S.; Fragments of Earth Lore, by Prof. James Geikie, F. R. S.;

In the last century, Swedenborg, Linnæus, Pallas, De Luc, and many other eminent writers took notice of the remarkable fact that in Scandinavia, Russia, Germany, and Switzerland detached rocks or bowlders were found, often in great abundance and of immense size, and of a kind that did not exist *in situ* in the same district, but which were often only to be discovered in remote localities, sometimes hundreds of miles away. Those who ventured to speculate on the origin of these traveled rocks usually had recourse to water power to account for their removal; and as their large size and often elevated position required some unusual force to carry them, there arose the idea of enormous floods sweeping over whole continents; and for a long time this diluvial theory was the only one that appeared to be available, although the difficulties of its application to explain all the phenomena became greater the more closely those phenomena were studied. Still, there was apparently no other known or conceivable means of accounting for them, and for the enormous mounds of gravel or clay intermixed with bowlders which often accompanied them; and the efforts of geologists were therefore directed to the discovery of how the water power had acted, and by what means the supposed floods could have been produced.

There were not wanting men who saw that no action of water alone could account for the facts. Sir James Hall pointed this out with regard to erratics on the Jura, whose source was undoubtedly in the far-distant Alps; and Mr. Grainger, in America, described some of the parallel grooves and flutings running for nearly a mile in Ohio, strongly arguing that no action of running water could have produced them, but that an agent was required the direction of whose movement was fixed and unalterable for long distances and for a great length of time. No light was, however, thrown on the problem till 1822, when Venetz, a Swiss engineer, finding that existing glaciers varied in extent from year to year and that historical records showed them to have considerably increased during the last eight centuries, was further led to observe that long before the historical era the glaciers had been immensely more extensive, as shown by the smooth and rounded rocks, by longitudinal scratches and grooves pointing down the valleys, and by numbers of old moraines exactly similar in form and materials to those deposited by existing glaciers. He read a paper before the Helvetic Society of Natural History, and urged that glaciers once stretched down the Rhone Valley as far as the

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Man and the Glacial Period, by Prof. G. F. Wright, F. G. S. A.; La Période Glaciaire, by A. Falsan; and the Glacialist's Magazine, edited by Percy F. Kendall, F. G. S.; from which works, and from those of Lyell, Ramsay, Geikie, and the American geologists, most of the facts referred to in the present article are derived.

Jura, and there deposited the erratic blocks which had so puzzled the diluvialists to explain.

Other writers soon followed the clew thus given. In 1835 Charpentier, after a close study of the erratic blocks and of their sources, adopted the views of Venetz. Agassiz followed, and by his strenuous advocacy did much to spread correct views as to the former extension of the Alpine glaciers, and their capability of explaining the numerous superficial phenomena which in all northern countries had been thought to afford proofs of enormous floods and of the submergence of a large part of Europe under a deep sea. He has, therefore, gained the reputation of being the originator of the modern school of glacialists, which undoubtedly owes much to his energy, research, and powers of exposition, though all the more important facts, as well as the logical conclusions to be drawn from them, had been pointed out by previous writers.

Before proceeding further, it will be well to give a brief outline of the phenomena which lead to the conclusion that glaciers have formerly existed in districts and countries where even perpetual snow on the mountain tops is now unknown. These may be briefly classed as—1. Moraines and drifts. 2. Rounded, smoothed, or planed rocks. 3. Striæ, grooves, and furrows on rock surfaces. 4. Erratics and perched blocks.

1. Moraines are those heaps or ridges of rock and other *débris* which are deposited on the surface of a glacier from the precipices or mountain slopes which border it, and which form what are termed lateral and medial moraines while upon it, and terminal moraines when, being gradually discharged at its end, either from above or from beneath it, they form great heaps of rock and gravel corresponding in outline and extent to that of the terminal ice-cliff. Such moraines can be seen on and near all existing glaciers, and their mode of formation and characteristics are perfectly well known. If the glacier is continuously retreating, then the terminal moraine will form more or less irregular heaps over the surface the glacier has formerly covered; but when, as is usually the case, the glacier remains stationary for a considerable period, then the terminal moraine will have a definite form, and will often stretch quite across the valley, but presenting one or more openings through which the glacier stream has cut its way. Such moraines form steep mounds, usually curved and often very regular, seeming from a little distance to block up the valley like an artificial earthwork. Among hundreds that might be enumerated, good examples may be seen in Glen Isla (Forfarshire), in the Troutbeck Valley near Windermere, and in Cwm Glas, on the north side of Snowdon, this latter being so regularly curved, evenly sloped, and level-topped as to look from below

exactly like an ancient fortification. The characteristic features of moraines are their position in valleys where there are other indications of glacial action, their steep slopes and often level tops, but especially their composition of earth, stones, and gravel, with large fragments of rock irregularly scattered through them from top to bottom without any sign of stratification, while usually one or more large blocks rest upon their summits in positions where they could only have been left by the retreat of the glacier, or possibly stranded from floating ice. Where extensive glaciers have covered large areas of nearly level ground, the moraines form great sheets extending for many miles, often concealing the original contours of the country, and then receive the general name of drift. The composition of drift is usually the same as that of well-marked moraines, large blocks of stone being distributed throughout its mass. It is this which mainly distinguishes drift from alluvial or shore deposits, in which the materials are always more or less assorted and stratified; but the angular forms of many of the contained blocks and the striated surfaces of others are also characteristic. Besides the terminal moraines of extinct glaciers, lateral moraines are also left along the slopes of open valleys from which glaciers have retreated. As a whole, moraines are well distinguished from all accumulations formed by water, and it has not been shown that any other agency than glaciers is capable of forming them. In all recently glaciated countries they are to be found more or less frequently, and thus afford an excellent first indication of the former existence of glaciers.

2. Smoothed and rounded rocks, called in Switzerland "roches moutonnées," from their supposed resemblance at a distance to sheep lying down, are perhaps the most general of all the indications of glacial action. Every glacier carries with it, imbedded in its under surface, numbers of rocks and stones, which, during the slow but unceasing motion over its bed, crush and grind down all rocky projections, producing in the end gently rounded or almost flat surfaces even on the hardest and toughest rocks. In many of the valleys of Wales, the Lake District, and Scotland every exposed rock has acquired this characteristic outline, and the same feature can be traced on all the rocky slopes, and often on the summits of the lesser heights; and the explanation how these forms have been produced is not a theory only, but has been observed in actual operation in the accessible portions of many glaciers. Rocks and stones are to be seen imbedded in the ice and actually scratching, grooving, and grinding the rock beneath in their slow but irresistible onward motion. The rocky islets in Windermere, Ullswater, and other lakes, as well as the Thousand Islands of the St. Lawrence, are thus ice-ground; and the amount

of the grinding can often be seen to be proportional to the pressure and motion of the advancing glacier. I recently noticed in the marshy alluvial plain above Derwentwater a projecting rock which has been ground down to so regular a curve as to look like a portion of an enormous globe buried in the earth. By rough measurement and estimate this rock was about two hundred and fifty feet across, and twenty or thirty feet high. It was formed of hard slate, with numerous quartzite veins, the whole ground down to a uniform spherical surface. It had evidently once been an island in the lake, having a much broader base now hidden by the alluvium, and may originally have been one of those abrupt craggy rocks a few hundred feet high, which, owing to their superior hardness or tenacity, resisted ordinary denudation, and which, when above the old ice-level, form those numerous "pikes" which add so much to the wild and picturesque scenery of the district. Looking at such rocks as this, with outlines so utterly unlike any that are produced in similar formations by subaërial denudation—and they are to be seen by scores in all glaciated regions—we can not but conclude that the ice tool has done more than merely rub off the angles and minor prominences, and that it has really ground away rocky hills to an unknown but very considerable extent; and this conclusion is, as we shall see, supported by a very large amount of confirmatory evidence. It may be noted that ice-ground rocks usually show the direction in which the ice has moved, by the side opposed to the motion being more completely smoothed than the lee side, which often retains some of its ruggedness, having been protected partly by the ice overriding it and partly by the accumulation of its own *débris*. Where such rocks occur in the higher parts of valleys the smooth side always looks up the valley from which the glacier has descended. In the more open parts of valleys, or in high coombs or cirques, where two or more small ravines meet and where the ice may have been embayed and have acquired a somewhat rotary motion, the rocks are seen to be ground down on all sides into smooth mammillated mounds or hummocks, showing that the ice has been forced into all the irregularities of the surface. An example on a small scale is to be seen in Cwm Glas, on the north side of Snowdon, above the fine moraine already mentioned, and in many other places around the same mountain. On the whole, considering their abundance in all glaciated regions, and the amount of information they give as to the direction and grinding power of ice, these rounded rocks afford one of the most instructive indications of the former presence of glaciers; and we must also agree with the conclusin of Darwin (in a paper written after studying the phenomena of ice-action in North Wales, and while fresh from his observations of glaciers and icebergs in the South-

ern hemisphere) that "one of the best criterions between the effects produced by the passage of glaciers and of icebergs is boss or dome-shaped rocks."

3. Striated, grooved, and fluted rocks, though closely connected with the preceding, form a distinct kind of evidence of the greatest value. Most of the bosses of rock just described have been exposed to the action of the atmosphere, perhaps since the ice left them, and have thus become more or less roughened or even disintegrated; but where the rocks have been protected by a covering of drift, or even of turf, and have been recently exposed, they often exhibit numerous parallel striæ, varying from the finest scratches to deep furrows a foot or more in diameter. Fine examples are to be seen near the lakes of Llanberis, and they occur more or less frequently in every glaciated country. Perhaps none of the effects of ice so clearly demonstrate the action of glaciers as opposed to that of icebergs, owing to the general constancy of the direction of the striæ, and the long distances they may be traced up and down slopes, with a steadiness of motion and evenness of cutting power which no floating mass could possibly exert. Sir A. Geikie tells us that in Gareloch, Bute, and Cantyre the striations on the rocks run up and over the ridges, and are as clearly shown on the hill tops as in the valleys. Mr. D. Mackintosh states (in his paper on the Ice-sheet of the Lake District and of North Wales) that in the valley above Windermere the striæ cross Rydal Fell, Loughrigg Fell, and Orrest Head, ascending and descending their slopes, often obliquely. But it is in the United States that the most remarkable rock-groovings are to be found, extending over a large portion of the northeastern States. In his report on The Rock-scorings of the Great Ice Invasions Mr. T. C. Chamberlin gives many fine illustrations, from photographs, showing striæ and grooves along sloping, curved, or vertical surfaces, the striæ following the changes of curve, so that the grinding material must have been slowly forced into close contact with the irregular surface. Of one of these examples Mr. Chamberlin says:

The climax of adaptability is reached in the striation of warped and twisted surfaces, and of tortuous valleys. One of the most remarkable known instances of this within the limits of photographic illustration is furnished by the great glacial grooves at Kelly's Island (Fig. 17). These exhibit not only the pliancy of the ice, but at the same time its strong hold upon the armature with which it did its work of abrasion, grooving, and striation. For, while these grooves can scarcely be supposed to have been originated *de novo* by the gouging action of the ice, they are, nevertheless, plowed with deep furrows, the symmetry, continuity, and peculiar form of some of which are only intelligible on the supposition that they were cut by a single graving tool, held with sufficient tenacity by the ice to execute by a single movement a deep, sharply defined groove. There is, perhaps, no finer illustration of the pliancy with which the ice yielded to its encompassing

barriers, the tenacity with which it held its armature, and withal the pressure that both forced it into compliance with its tortuous channel, and pressed it relentlessly forward.*

Kelly's Island is at the western end of Lake Erie, and in the direction of the striæ to the northeast there is no high ground for about four hundred miles. Looking at these facts, I can not give any weight to the opinions of those who, from observations of existing glaciers, declare positively that ice *can not* go up-hill, and can exert *no* grinding power on level ground.

4. Erratic blocks were among the phenomena that first attracted the attention of men of science. Large masses of granite and hard metamorphic rock, which can be traced to Scandinavia, are found scattered over the plains of Denmark, Prussia, and northern Germany, where they rest either on drift or on quite different formations of the Secondary or Tertiary periods. One of these blocks, estimated at fifteen hundred tons weight, lay in a marshy plain near St. Petersburg, and a portion of it was used for the pedestal of the statue of Peter the Great. In parts of North Germany they are so abundant as to hide the surface of the ground, being piled up in irregular masses forming hills of granite bowlders, which are often covered with forests of pine, birch, and juniper. Far south, at Fürstenwalde, southeast of Berlin, there was a huge block of Swedish red granite, from one half of which the gigantic basin was wrought which stands before the New Museum in that city. In Holstein there is a block of granite twenty feet in diameter; and it was noticed by De Luc that the largest blocks were often found at the greatest distance from the parent rock, and that this fact was conclusive against their having been brought to their present position by the action of floods.

It is, however, in Switzerland that we find erratic blocks which furnish us with the most conclusive testimony to the former enormous extension of glaciers; and as these have been examined with the greatest care, and the facts, as well as the main inductions from the facts, are generally admitted by all modern writers, it will be well to consider them somewhat in detail. It will be found that they give us most valuable information both as to the depth and extension of ancient glaciers, and also to the possibilities of motion in extensive ice-sheets.

The most important of these facts relate to the erratic blocks from the higher Alps, which are found on the flanks of the Jura Mountains wholly formed of limestone, on which it is therefore easy to recognize the granites, slates, and old metamorphic rocks of the Alpine chain. These erratic blocks extend along the Jura

* Seventh Annual Report of the United States Geological Survey, p. 179. Arrangements have now been made for the preservation of these remarkable examples of ice-work.

range for a distance of one hundred miles, and up to a height of two thousand and fifteen feet above the Lake of Neufchâtel. The first important point to notice is that this highest elevation is attained at a spot exactly opposite, and in the same direction as, the Rhone Valley, between Martigny and the head of the Lake of Geneva, while north or south of this point they gradually decline in elevation to about five hundred feet above the lake. The blocks at the highest elevation and central point can be traced to the eastern shoulder of Mont Blanc. All those to the southwest come from the left-hand side of the lower Rhone Valley, while those to the northeast are all from the left side of the upper Rhone Valley and its tributaries. Other rocks coming from the right-hand side of the upper Rhone Valley are found on the right hand or Bernese side of the great valley between the Jura and the Bernese Alps.*

Now, this peculiar and definite distribution, which has been worked out with the greatest care by numerous Swiss geologists, is a necessary consequence of well-known laws of glacier motion. The *débris* from the two sides of the main valley form lateral moraines which, however much the glacier may afterward be contracted or spread out, keep their relative position unchanged. Each important tributary glacier brings in other lateral moraines, and thus when the combined glacier ultimately spreads out in a great lowland valley the several moraines will also spread out, while keeping their relative position, and never crossing over to mingle with each other. So soon as this definite position of the erratics was worked out it became evident that the first explanation—of a great submergence during which the lower Swiss valleys were arms of the sea and the Rhone glacier broke off in icebergs which carried the erratics across to the Jura—was altogether untenable, and that the original explanation of Venetz and Charpentier was the true one. Sir Charles Lyell, who had first adopted the iceberg theory, gave it up on examining the country in 1857 and ascertaining that the facts were correctly stated by the Swiss geologists; and there is at the present day no writer of the least importance who denies this. Sir Henry Howorth, who is one of the strongest opponents of what he considers the extreme views of modern glacialists, gives a full summary of the facts as to the old Rhone glacier from Charpentier. He states that between Martigny and St. Maurice the moraine *débris* on each side of the valley shows the glacier to have reached a height of three thousand feet above the river; farther on, where the valley widens over the Lake of Geneva, it sank to

* A map showing the lines of dispersal of these erratics is given in Lyell's Antiquity of Man, p. 344, and is reproduced in my Island Life, p. 111.

two thousand feet, while on the Jura itself it seems to have been again raised to three thousand feet at its highest point;* and he quotes Charpentier's general conclusion:

It goes without saying that not only all the valleys of the Valais were filled with ice up to a certain height, but that all lower Switzerland in which we find the erratic *débris* of the Rhone Valley must have been covered by the same glacier. Consequently all the country between the Alps and the Jura, and between the environs of Geneva and those of Soleure, has been the bed of a glacier.

And then, after quoting the observations of Agassiz on the same phenomena and of those of North America, he gives his own conclusions in the following words:

It is plain to those who would look without prejudice that the rounded and mammillated surfaces, the scratched, polished, and grooved rocks, and a great number of the phenomena which accompanied the distribution of the bowlders and the drift, are consistent only with the fact that in the last geological age there was an immense development of glaciers which occupied not only the high ranges of the Alps and the Dovrefelds, but the secondary ranges and lower heights of the continents of Europe and North America. This conclusion seems supported by every form of converging evidence, and is apparently beyond the reach of cavil. So far there is no question at issue.†

We may take it, therefore, that the views of Charpentier, Agassiz, and Sir Charles Lyell as to the extent and thickness of the great Rhone glacier are admitted to be correct, or, at least, not to be exaggerated, by the most strenuous opponents of the extreme glacialists. We may, therefore, use this as a fixed datum in our further investigations, and I think it will be found to lead us irresistibly to conclusions which in other cases these writers declare to be inadmissible.—*Fortnightly Review.*

The cities and towns visited by the Rev. J. A. Wylie during an excursion to central Manchuria in September and October, 1892, were centers of trade for the surrounding country, many of them having very large distilleries, inn-yards of great extent capable of accommodating hundreds of guests, and oil-works of various kinds; while outside their walls were generally some brick-kilns, brick-works, and lime-kilns. The houses were chiefly built of brick; burned brick was used for the better houses in the town, while unburned brick or mud only was used in the country. In some of the towns the shop-fronts were quite imposing, substantially built, and lavishly decorated. The streets were wide and level. Mr. Wylie visited the region in the dull season, and saw, either in town or country, none of the stir which all these arrangements betoken for the busy season.

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* These figures are almost certainly incorrect, as the upper surface of the glacier must have had a considerable downward slope to produce motion. The recent work of M. Falsan, La Période Glaciaire, gives the thickness as about 3,800 feet at the head of the lake and 3,250 feet at Geneva.

† The Glacial Nightmare and the Flood, p. 208.

THE FOUNDER OF THE FIRST SCIENTIFIC JOURNAL.

By M. JACQUES BOYER.

WHEN recently the statue of Theophrast Renaudot, the founder of French political journalism, was unveiled, the literary and scientific journals were alike full of praises of him and his work; but none of them recollected another pioneer in his field, the modest and profoundly erudite Denis de Sallo, the founder of the Journal des Sçavants, who did for letters and science what Renaudot so successfully accomplished for politics.

Without undertaking a full sketch of the history of the French scientific press, I desire only to show here how new in 1665 was that idea, which seems so simple and natural now, of the creation of a scientific journal; how many impediments were raised against its creator by the commonplace authors whom the new tribunal condemned without appeal; what patience, what erudition, what a prodigious sum of labor were required from its founders to surmount all the obstacles, avoid all the perils they met every day, and give their work a vitality strong enough to permit it, rising repeatedly from its ashes, to perpetuate itself till our time.

Denis de Sallo, Seigneur of la Coudray, was born in Paris in 1626, of an old noble family of Poitou. His lessons in early childhood were not brilliant; but after he entered the courses of rhetoric at the Collége des Grassins he obtained all the prizes of his class; became in the next year a distinguished pupil in philosophy, and having sustained in public remarkable theses in Latin and Greek, gave himself up with ardor to the study of law. His advance was so rapid that he was able in 1652 to succeed his father, Jacques de Sallo, in his office as counselor at the Parliament of Paris. Three years later he married Elizabeth Menardeau, daughter of a counselor in the Grand Chamber, by whom he had one son and four daughters. He died on the 14th of May, 1669, of apoplexy. His death, according to Vigneuil Marville, was caused by the loss of all his fortune in gambling in 1665; but, besides that this story has little probability in view of the character of De Sallo, who was industrious through all his life, it is controverted by a letter of Guy Patin's of the 13th of November, 1665, which proves that at that time De Sallo had no thought of dying, and by the testimony of Père Honoré de Sainte Marie, who agrees with Moréri in placing his death in 1669 and not in 1665.

Having given an outline of the principal events of De Sallo's life, which was otherwise quiet enough, we pass to the study of his character and work. "He read all sorts of books," says Moréri, "with incredible care, and kept secretaries continually employed to write down his reflections and the passages which he

marked, so that by this plan of studying he fitted himself to compose treatises on every kind of subject, as he showed on several occasions."

It was probably the considerable quantity of material that he collected in this way that suggested to him the thought of giving the public those extracts the utility of which he had recognized in his experiences. He associated with himself in the execution of this work, which was colossal for that time, a number of men of science and letters: De Bourzeis, a distinguished theologian; De Gemberville, chaplain, the famous author of La Pucelle; and the Abbé Gaulois, who, according to Fontenelle, seemed "born for that work"; but De Sallo revised all the articles—not very numerous—which his colaborers furnished, and himself wrote the largest number.

The authorization having been obtained, the support of Colbert assured, and the plan and periods of publication fixed, the Journal des Sçavants appeared on Monday, January 3, 1665, in a sheet and a half quarto, under the pen signature of Hedouville;* and it continued to appear every Monday till the 30th of March of the same year, when the authorization was withdrawn. Although its criticisms were always moderate and just, it had made many enemies among men of letters, and among the Jesuits, then all-powerful, "who were not pleased to see a literary and philosophical tribunal that was not set up by them, and who, moreover, detested De Sallo and his friends as Parlementarians and Gallicans suspected of Jansenism; these added their complaints to the cries of wounded self-love. They secured the aid of the papal nuncio, and he obtained a prohibition against De Sallo's continuing the publication." The pretext alleged for this act was a passage in the Journal in which De Sallo criticised a decree of the Inquisitors, "whose delicate ears required so great circumspection."

Colbert, however, still retained a friendship for his client, recompensed him for the suppression of his journal with an office in the treasury, and, realizing the full value of De Sallo's work, commissioned the Abbé Gaulois to continue it. The Journal reappeared on the 4th of January, 1666, and was henceforth illustrated;† but Abbé Gaulois, who held the direction of the

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* The name of one of his servants.

† As a specimen of the illustrations, we mention a superb engraving representing a louse as seen under the microscope; it measures not less than forty or fifty centimetres (year 1666, page 292 of the reprint of 1729). This reprint is a nearly textual reproduction of the original edition, which is now very rare. It is well to remark here that the Journal des Sçavants, like all similar journals of the seventeenth and eighteenth centuries that were successful, was reprinted as the numbers were exhausted; thus in the set that I have consulted at the library of the Arsenal, the year 1665 is of 1733, and the year 1666 of 1729, while the year 1676 was reprinted in 1717. Hence it is almost impossible to find two col-

paper for nine years, published it very irregularly; thus there was only one number in 1670, and none in 1673.

In 1675 the Journal passed into the hands of Abbé La Roque, who exhibited in his work a punctuality worthy of praise, but was far from knowing as much of science as his predecessor; then in 1686 Chancellor Boucherat, who declared himself its protector, intrusted its direction to President Cousin. Finally, in 1701, the Journal was acquired for the state by Chancellor de Pontchartrain, who gave the preparation of the numbers no longer to one man, but to a company of students, consisting of Dupin, Rassicad, Andry, Fontenelle, and Vertot, with Julien Pouchard as director. Thus renewed, supported by Abbé Bignon, nephew of the chancellor, the Journal des Sçavants appeared again on the 2d day of January, 1702, and its history till 1792, when political events compelled its suspension again, offered the single noteworthy feature that its period of publication was changed in 1764, and from a weekly it became a monthly, with supplements every six months.*

Sylvestre de Sacy tried to resuscitate the Journal in 1796; but his attempt was abandoned after the publication of twelve numbers, from the 16th of nivose to the 30th of prairial of the year V. It was re-established September 1, 1816, on the proposition of Barbé Marbois, Keeper of the Seals, and Dambray, chancellor, on a report of the historian Guizot, then general secretary to the Minister of Justice, and has not been suspended since. The presidency of the editorial committee appertained to the Keeper of the Seals from that time till the imperial decree of May 4, 1857, by which it was transferred to the Minister of Public Instruction, under whose auspices the Journal is still published.

Such has been the checkered career of the first French scientific journal—a career that demonstrates, better than any eulogy can, that the work of De Sallo possessed the qualities of merit and utility which make intellectual work fruitful and durable.

The detailed history of the Journal des Sçavants may be found in Hatin, Histoire politique et littéraire de la presse en France, 1859, vol. ii, p. 151, and those following; and in the Mémoire historique sur le Journal des Sçavans, in the table of the Journal, by the Abbé de Claustre, 1764, vol. x, 595 and following pages.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

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lections of the sets exactly alike. If we add to this that the publisher has sometimes intercalated notes in the reprints without indicating that they were not in the original edition, and that some of the series have been counterfeited in Holland, one may have some idea of the difficulty of the investigation and of the lamentable differences of the editions.

* There were also supplementary volumes for each of the years 1707, 1708, and 1709, and in 1773 only the five numbers of the first five months were published.

SKETCH OF JEAN MARTIN CHARCOT.

A GREAT deal has been added to our knowledge of nervous disease by the labors of Charcot; and extensive fields of investigation hitherto untried have been opened by him.

JEAN MARTIN CHARCOT was born in Paris, France, November 29, 1825, and died near Château Chinon, le Morvan, France, whither he had gone on a pleasure trip with a few friends, in August, 1893. He was industrious in his youth, acquitted himself brilliantly in his classical studies, and, when the time came for choosing his profession, hesitated whether to become an artist or a doctor. Against the latter was the expense of preparing for the profession, but, encouraged by the assurances of his father, who preferred that line, he began the study in 1845. He became *chef de clinique* in 1852, and obtained his degree in 1854. Having obtained several prizes, by which attention was drawn to him, he became a hospital physician in 1856, an adjunct professor in the University of Paris in 1860, and was appointed physician at the hospital of La Salpêtrière in 1862. Here he spent the remainder of his active life, and prosecuted the researches which have made his name famous throughout Europe and America. "In order," the Lancet says, "properly to appreciate the ability which he brought to bear upon his work and the enthusiasm which he could inspire it should be remembered that when he began his now well-known *Leçons* at the Salpêtrière the institution was little less than an ill-assorted collection of five thousand women, comprising the aged, the imbecile, the idiotic, the epileptic, and the paralyzed, in which scarcely an attempt had been made to extract from the wealth of material anything more than a narrow individual experience. In a few years it had been transformed into the very Mecca of neurologists, and this it has remained up to the present time." Besides teaching in his clinic at the Salpêtrière, Charcot conducted an external course in pathology at the *École pratique*. He was given the chair of Pathological Anatomy at the Faculty of Medicine in Paris in 1875, and filled it till 1883. Since 1877 he elucidated with a rare clearness of vision a large number of questions relating to diseases of the liver, kidney, and spinal marrow. He enriched physiology by contributing to the celebrated theory of cerebral localizations. All his studies have borne fruit; they touch a multitude of problems of cerebral pathology or of nervous affections, and have been fertile in practical results, especially as concerns locomotor ataxia, medullary perturbations, aphasia, hysteria, and epilepsy. As Dr. G. Daremburg observes in a notice of him, "He brought order and precision into a multitude of questions which were

in utter disorder previous to him." His chief work was his study of nervous diseases. For years his lectures in the Salpêtrière on neurosis, hypnotism, and the different forms of hysteria attracted universal attention. In no official chair had the attempt been hazarded to take up the study of that series of occult phenomena which have excited public curiosity and baffled the sagacity of observers from ancient times. Charcot subjected these strange phenomena to the precise examination of the experimental method. He studied them with keen vision, so as to be able to reproduce them at will, and often revealed the existence of extraordinary facts which had been before regarded as chimerical. Although his conclusions may sometimes transcend the limits of scientific rigor, it is nevertheless true that he cast a new light on a whole region of investigation hitherto concealed in the dark. Besides making new medical discoveries in this line of research, he opened fresh horizons to science, initiated many pupils, and founded a new school, widely known now as the School of the Salpêtrière.

In connection with the Salpêtrière he founded a laboratory, an anatomo-pathological museum, electro-therapeutic wards, and a photographic studio, where he pictured sections of diseased brains and spinal cords, and formed a collection of portraits of neuropathic patients.

In his studies of gout and the maladies arising from it, to which he gave great attention in the early years of his practice, he discovered relations between disorders which had till then been thought independent of one another. He traced certain kinds of deafness, arthritic rheumatism, and kidney disease to gout, and found the origin of that disease in an overwrought liver and a sluggish skin. Pulmonary diseases also engaged his attention. In his lectures on phthisis he held that all caseation is essentially a tuberculous process, and assigned a secondary place to pneumonic phenomena.

Having been born at the time of the reaction in favor of clericalism, which was encouraged by the devotedly Catholic court of Charles X, and intensified the disgust of the freethinking people of Paris, Charcot grew up with a strong tendency toward extreme heterodoxy. He delighted later in life in demolishing the fetiches set up by the priests with which his investigations brought him in contact; and as Mrs. Crawford says, in the London Illustrated News, "humored the irreligious people in power by reducing the Lourdes and other miracles to suggestion. Gambetta, Naquet, Paul Bert, and other political atheists attended his lectures. He produced the phenomena of stigmates on hysterical girls." In like manner he pointed out analogies in other forms and manifestations of hysteria or hypnotism with

various signs and wonders of religious history and tradition. Regarding them all as remarkable hypnotics, the mystics of the past were favorite subjects of contemplation with him. He accumulated the works of the mystical painters, Andrea del Sarto, Deudato Delmont, Matteo Roselli, and Van Breughel, and read the works of the great mystical writers—Thomas à Kempis, Fénelon, Pascal, and St. Francis of Sales. Hysteria had before this time been regarded as peculiarly the disease of women. He found it attendant upon many forms of disorder from which men suffer, detected it in some of their petty weaknesses and vanities, and regarded it as lying at the bottom of the literary peculiarities of some of the most popular French authors.

He was an intense materialist, and in this he and his school were directly opposed to the other school of alienists in France, that of Nancy and the Charité Hospital, who supposed a psychical force behind the phenomena which came under their observation. With this he had a touch of intolerance toward his opponents. At his demonstrations, according to Mrs. Crawford, he "seemed to command every nerve of his patients. There were but two seats in the room where he taught—one for himself and the other for the patient. The students, disciples and laics—which last came in crowds—stood, some taking notes, and others listening with profound attention. He flattered himself that he forced by the mere power of his will the idlers to be attentive. There was nothing he more resented than for persons of rank, whom he thought not competent to understand him, to compliment him. . . . He began to lose his power 'to fascinate' his pupils some time before his death, and noticed it with sorrow. Though he despised the eulogiums of the incompetent, or wanted no conventional praise, he enjoyed feeling that he was celebrated."

Charcot's literary work was considerable. He published a large number of memoirs, articles, and studies on chronic and nervous diseases, rheumatism, and softening of the brain; and his writings are known, appreciated, and sought for in all countries. His lectures have been translated into several languages. The Lancet, in its estimate of his publications, says: "It is rather more than twenty years since the first part appeared of Leçons sur les Maladies du Système Nerveux. Modest and unpretending, with a gray paper cover and no great thickness of letterpress, the publication was somewhat long in attracting general attention among the profession in this country (England); but to those who had the good fortune to open the *brochure*, what a wealth of interest was laid bare! Custom has made us so familiar with M. Charcot's style that it is difficult to describe the charm of a first introduction to his writings. Putting aside for an instant the scientific value of the material, there was something in the writ-

er's graphic power of imparting information which came with extraordinary force, even upon those who had lingered with delight upon the pages of Watson or Trousseau. In Charcot's case it was not merely that we descried an astonishing facility of picturing by the pen, but above and beyond this was the evidence of the influence of a fresh and powerful mind pervading every paragraph. Lesions of the nervous system formerly huddled together and massed under some name which, pretending to describe, had only obscured, began to emerge with a sharp outline and clearly differentiated form. . . . The written works of Charcot naturally fall into two great divisions—those dealing with nervous diseases generally, and those concerned with the more recondite and abstruse phenomena of hysteria and hypnotism. Probably his most notable works are his Lectures on Nervous Diseases and his volume on Cerebral Localization, both of which are accessible to English readers in the Sydenham Society's translations. In these are chronicled the great advances in our knowledge of nervous symptoms and nervous pathology with which Charcot's name will always be associated." A communication published in the Archives de Physiologie in 1868, on the condition known as "Charcot's joint," is also mentioned as one of his most interesting and important contributions.

Charcot's manner is described as having been short, "but in his way he was kind to his incurables," and "he felt remorse for having treated unfortunate patients as if they had no more feeling than subjects for dissection." He "was truth itself, but he wanted imagination, and was for that reason unable to look with any eyes but his own upon effects and their various causes." In private conversation he had none of the impatient vivacity frequently associated with the French manner. "He was anything rather than loquacious. An attentive, respectful, and sympathetic listener, he ever avoided any dogmatic expressions of opinion, even when dealing with subjects upon which his thought and experience had given him more than ordinary qualification for pronouncing judgment. He would listen with interest to a suggestion, conflicting perhaps with some published opinion of his own, and then, lifting his hands and shoulders with a little expressive gesture, would quietly say, 'It may be so.' He was fair and just in his references to the work of others." A resemblance has been remarked in his face and figure to the conventional type of an abbé.

EDITOR'S TABLE.

THE CONDITIONS OF EFFICIENT GOVERNMENT.

WHEN a private employer of labor wants work well done he tries to employ, in the first place, persons who are presumably, and to the best of his judgment, competent to do it well, and then he gives them an opportunity to show what their qualifications really are. He tests their work as they go on in every way possible, and, if he finds it satisfactory, he congratulates himself on the excellent service he is getting and on the prospect of still better results in the future as his workmen, clerks, superintendents, or whatever they may be, acquire greater experience. If any one were to come and suggest to him to inquire into the political opinions of his assistants and to replace any who did not think quite as he did by inexperienced persons whose one certified virtue was that their political complexion was exactly the same as his own, he would conclude that he had struck a lunatic, and would probably inform the gentleman that such was his opinion.

But, turning to the people of the United States, we may say, in the words of the Roman poet, "The story is told of you with a simple change of name." Yet, after all, there is more than a change of name; for we have assumed that the private employer of labor would treat the person who made such a suggestion to him as a lunatic; but not so do the people of this country treat those who make like suggestions to them. Far from it; they have in past times appeared to find such advice good, and have made those who gave it their trusted counselors. They have cut short the official careers of men who had just begun, after a few years' necessary experience, to be fully competent in their several positions, in order that the work might be taken up by incompetent (because inexperienced) men of a different political profession of faith, on the understanding that the latter should remain in office only so long as their party was "on top" or so long as they themselves continued to be meet instruments of party policy. A given official might at a given moment be carrying on important investigations, the various threads of which were gathered in his own hands and head—possibly a post office inspector trying to get on the track of a series of mail robberies, or a customs officer similarly employed as regards frauds on the revenue, or a statistician marshaling an elaborate array of facts by methods which he himself had carefully devised and could alone apply with the best results, or the head of some scientific bureau who, after a battle with disorganization and sloth and the indifference bred of the political system, had conquered the forces of opposition, established order, and prepared the way for a vigorous advance of the important work committed to him—what would it matter?—whatever he was, or whatever he was doing, when the hour came that a stronger than he politically wanted his place, the supposed guardian of the public interests, cabinet minister or President, would order his dismissal, and bring in the new man to throw everything into confusion, or, at the very least, to retard in a more or less serious degree operations that might have been carried on without a break, to the great advantage of the community.

We do not mean to say that changes have never been made for the better. That has been as it chanced; and certainly under our system changes for the better have for the most part been only too possible. Who that has any ac-

quaintance with the public service of the country is not thoroughly familiar with the official in the last year or so of his term, looking forward to removal and too profoundly discouraged to throw any zeal into his work, or to form any plans for putting things around him into better shape? We have seen him and know whereof we speak, nor will it be devised that the type abounds in the country to-day. As to plans for the future, the simple knowledge that his successor in office will want to do things in his own way, and will lack the experience necessary to the appreciation of arrangements based on experience, would alone dispose the retiring official to live a kind of hand-to-mouth existence till his change came.

Even as we write this article we notice by the dispatches from Washington that the excellent appointment made by the last administration of Prof. T. C. Mendenhall to the superintendence of the Coast Survey is in danger of being canceled in the interest of a Democratic aspirant to the office. There does not appear to be any pretense that Prof. Mendenhall is not in all respects suited to the office he fills, or that he has not already rendered very valuable service in it. It is stated, indeed, in journals not unfavorable to the present administration that he has been and is most efficient, and that under his management the survey is doing better work than ever before; and yet the wolves are howling round him, and the impression is gaining ground that the wolves are to be satisfied. Now, if the public would only reflect a little on what this means and what it costs, we think there would be a more serious revolt against the subordination of civil administration to party politics than this country has witnessed yet. We either want good, faithful, and intelligent service or we do not. If we do, then we must also want the means to the desired end; and an important part of the means will be a secure tenure of office for capable and faithful public servants. If we are indifferent as to the service we get, and wish to keep all the more important offices as rewards for partisan service, let us avow it distinctly and cease to be surprised when officeholders show that they understand why they were appointed and make the public interest as secondary in their own calculations as it was in that of those who gave them their positions. Of course, to avow this would be to accept a very low place in the scale of civilized nations, but if we can not screw our public virtue up to any higher pitch, let us at least honestly acknowledge where we stand.

A POSSIBLE REFORM.

The saying that "all is for the best in the best possible of worlds" is one which does not at every moment come home to us with conviction. It sometimes seems as if many things went unnecessarily awry, as if evil results were being incurred in many quarters through simple carelessness and indifference to the conditions of well-being. It is difficult, for example, to be quite satisfied with the general effects of popular education, or with the fruits which have as yet been reaped from the diffusion of scientific knowledge. If we ask whether the popular press exhibits a higher intellectual stamp than it did twenty or thirty years ago, the answer will not be altogether reassuring. It is within about thirty years that most of the devices now used by the press for taking the strain off the attention of lazy readers have been introduced; and what a development there has been within the same period in the ignoble industry of purveying and tricking out in all the adornments of newspaper rhetoric a kind of news for which the simplest considerations of public interest would prescribe the briefest and driest treatment, it is quite needless to declare.

We have noticed with pleasure lately

two or three articles drawing attention to the great evil which must undoubtedly be wrought by the highly colored and vigorously expressed representations of vice and criminality with which most of our daily papers teem. That such matter is read with avidity by a large class of the population is only too true; and with the average publisher, unfortunately, no other justification is needed for serving it up in unlimited measure and with the most piquant flavorings that his able "young men" can devise. Apart from the elaborate reporting of vicious and criminal actions, the press gives a large portion of its space to personalities of a very trivial character, which in their way exert almost as hurtful an influence as the more sensational matter. Nothing is more directly or fundamentally opposed to anything like nobility of nature than undue occupation of the mind with personal trifles, particularly when it takes the form of a prying curiosity regarding the private affairs of others. Anything more vulgar than the desire so widely manifested to tear aside the veils which persons who, in certain capacities, are obliged to come more or less before the public eye wish very naturally to draw over their private lives, could not well be imagined. Yet papers which in some respects deserve commendation make the very living of their reporters depend on the success they are able to achieve in this terrible business of destroying a lawful privacy, and encouraging the public to gaze with shameless intrusiveness upon scenes and incidents and sentiments with which they have nothing whatever to do, and which ought to be kept as inviolate as a letter in the mails.

The question of responsibility for the evil done to the community in these ways is one that is dismissed too lightly by those on whom it rests. True, within the limits within which most papers confine their operations, there is no civil tribunal that can interfere with them. Still, the question is a haunting one, "Am I or am I not, for a pecuniary consideration, inflicting deliberately and with full knowledge an injury upon society?" Granted that large numbers are craving for a depraved nutriment, is a man justified in meeting such a demand? If so, the thing may be carried further, and, however vicious the indulgence sought, the mere fact that there is a demand will justify him who undertakes to supply it. Yet there are trades from which many publishers whose journals are highly sensational would shrink. It is a question, evidently, as to where the line should be drawn; and it is a great pity that enterprising journalists can not see their way to drawing it a little nearer to sound morals and public duty.

The fact we have to face to-day is that an agency of unlimited range and influence exists for the popularization of evil, for filling the imagination of young and old with everything that is most unprofitable and pernicious from a moral and social point of view—tales of unbridled license, of violence and revenge, of selfishness and fraud. The same journals that contain this noxious stuff may also contain able editorial articles, and other more or less useful reading matter; but how many read the able editorials compared with the number of those who fasten chiefly or exclusively upon the gossip and the crime? Be the proportion or disproportion what it may, can the fact that a portion of the paper consists of good and useful matter furnish any defense for filling the rest of it with poisonous matter? Mr. Henry Wood, in an article in The Arena on The Psychology of Crime, cites very appositely the apostolic injunction, "Whatsoever things are true, honest, just, pure, lovely, and of good report," to "think on these things," and contrasts it with the invitation constantly held out by the press to drench the mind with thoughts of whatever is false, dis-

honest, unjust, disgusting, and of ill report. The contrast is indeed flagrant, and possibly the apostle, if he could be revived and given a week's reading of some very widely circulated daily papers, might be disposed to wonder that a community which openly and systematically violated an ethical precept so authoritative in its very simplicity as that which he had laid down, should still be very jealous for the name and character of Christian. Then, if he were regaled with a course of pink-tinted police literature, and had spread out before him the numerous illustrated purveyors of vileness that may be seen on most news-stands, he would be too profoundly discouraged, we fear, even to think of inditing a stinging epistle to the Church in these lands.

We do not need, however, to resurrect an apostle in order to arrive at a moral judgment on this matter. By every rule, both of psychology and of common sense, a certain kind of journalism is morbific in its tendency. It brings and is known to bring a plague in its train, perverting the thoughts of youth, and relaxing moral sanctions that are none too strong even in old age. The question then is, How long will it be before the better portion of the community rises in revolt against so great and unnecessary an evil? The ever-ready resort of some, when a reform is to be accomplished, is to legislation: that idea we wholly repudiate; legislation can not touch this particular evil. What is required is that intelligent and well-disposed people should discriminate between papers that treat acts of crime or moral disorder with brevity and reserve and those that seek to make capital out of them, bestowing as far as possible their support on the former and withholding it from the latter. This is a very simple remedy, but it would be wonderfully efficacious if tried on a large scale. But no one need wait for others in this matter. It is a thing which concerns the home, and no one should wait to see whether others are going to protect their homes before taking steps to protect his.

One other word before we leave this subject. When we get down to the root of the matter we find that all this morbid interest in what is evil and trivial arises from a lack of individuality. "You have no soul—that makes you weigh so light," says an old dramatist. It is those who have no deep personal interests of their own, no cultivated tastes, no definite opinions, nothing special to fix and characterize them as individuals, who are insatiable for gossip, and whose love for gossip naturally passes into a love for scandal and whatever else is morally miserable. Multiply individuals in the true sense, and scandal-mongering will just proportionately decline, while the scum-gathering which now forms so large a part of what is called "journalistic enterprise" will become a neglected and dishonored art. How large a part the teaching of science might play in the development of individuality we can not now attempt to indicate: we can merely say that here we see a field of infinite promise which has yielded but little as yet, simply because workers of the right stamp have been few.

THE MOON OF ROMANCE.

The novelists will not leave "the young moon" or "the crescent moon" alone, and three times out of four they contrive to get it into the wrong place. How to explain the conviction which haunts the minds of so many of them, that the crescent moon may be seen almost any fine evening rising gracefully in the east, is altogether beyond us. The point seems to be one for psychologists. Here is a thing that never was seen since the world began; and yet a number of otherwise sane gentlemen are firmly persuaded that it is a regularly recurring natural phenomenon. Surely the philosophy of this hallucination deserves investigation. The last

case that has come under our notice is in a well-written story called A Comedy of Masks, by Ernest Dowson and Arthur Moore. Two friends are sitting out one summer evening, looking over the Thames, and the story goes on: "By this time the young moon had risen, and its cold light shimmered over the misty river." A novelist need not be an astronomer, but he should at least try to draw from Nature, and should not pretend to have seen the young moon rising at the very hour when it was being packed off to bed. Some day, perhaps, a little acquaintance at first hand with the broadest facts of Nature will be thought a requisite for writing a good novel, but the time is not yet. Meantime, if our novelists would try to bear in mind that the young moon, like other young things, goes to bed early—that Nature does not trust it out late at night—they might get into the way of seeing it at the right time and in the right place, and not treat us to "cold shimmers" that are only moonshine in the least favorable sense of the term.

Since the foregoing was put in type our attention has been called to a precisely similar blunder in an article entitled Notes from a Marine Biological Laboratory, written by a man of science and a college professor, and printed in the February number of this magazine.

In the light of what has previously been said, the situation, we must confess, is decidedly awkward, and not at all to the credit of our editorial scrutiny. Yet, while freely admitting that the case is far less excusable than the one cited above, we are still inclined to regard it as an even more emphatic admonition that writers, and particularly writers on scientific subjects, are under obligations to know what they are talking about, and should also be able to subordinate their poetical ambitions to the requirements of truth.

LITERARY NOTICES.

The Recrudescence of Leprosy, and its Causation. A Popular Treatise. By William Tebb. London: Swan, Sonnenschein & Co., 1893. Pp. 20–21 to 412.

In the first chapter of this polemic against vaccination the author states that leprosy has greatly increased and is still increasing, and he cites as *evidence* reports from various countries that the disease is more or less prevalent. We submit that there is no evidence of the increase of anything, disease or other, unless facts are given regarding the number reported each year for a series of years. What social economist would be recognized that stated the population of a country was increasing because he saw more children in the maternity hospitals? What financier would be regarded as authority that said the country was richer because he had so many thousands of dollars deposited in his bank, though he was ignorant of the amount of deposits of fifty years previous?

Let us cite an example. Leprosy is increasing in the United States because Dr. Blanc reported forty-two cases of leprosy in New Orleans in 1889. We have practical personal knowledge regarding leprosy in Louisiana, and it is a statistical fact that leprosy is less prevalent there to-day than it was one hundred years ago, and, whether the hereditary causation is always known or not, the disease only affects those having creole ancestors. Dr. Allen's and Dr. Morrow's *speculations* regarding the increase of leprosy in this country are worthless, and are not accepted by the leading dermatologists.

No reference is made to the paper of Hansen, the discoverer of the lepra bacillus, who stated that his investigations among Norwegian lepers that had emigrated to the United States showed that the disease had died out among them.

An elaborate account of the increase of leprosy in India is given; and yet since the publication of this volume the Indian Leprosy Commission has made its report, and, while its figures suggest a decrease rather than an increase in the prevalence of the disease, the commission conservatively prefer to say that the leper population has remained stationary. This lack of the critical faculty in the author

is only equaled by his ignorance of the etiology and pathology of disease. Contagion, inoculation, and predisposition have to him a meaning that is alien to that attached thereto by the medical profession.

Our personal experience in Norway and the United States justifies our statement that if the author's reference to other countries is no more accurate than to these two, then, as a work on leprosy, the book is useless.

Its real purpose, however, is to promulgate the theory that the leprosy that exists to-day is perpetuated by vaccination. We can not trespass upon the space of these columns to discuss so unsubstantial a theory. One swallow does not make a summer, nor do one or more cases of leprosy inoculated with supposed vaccine sustain the author's thesis.

General Thomas. By Henry Coppée, LL. D. New York: D. Appleton & Co., 1893. Pp. 332. Price, $1.50. (Great Commanders Series.)

This volume of the series in no way falls behind the previous issues, either in the intrinsic interest of the man and his career, or in the style of treatment. General Thomas was born on July 31, 1816, in the southeastern portion of Virginia. Little is known of his early life. In his nineteenth year he began the study of law, but shortly afterward was offered a cadet appointment at West Point, which he promptly accepted. He was graduated in 1840, twelfth in his class. Thomas's first commission was that of second lieutenant in the Third Artillery. He joined his regiment on Governor's Island, New York Harbor, but was soon ordered south to take part in the Florida War, where he gained much distinction and slight promotion. After this he served at several of the Southern military posts. He was with General Taylor during the Mexican war, and was brevetted major for brilliant work.

His personal appearance, about 1850, is thus described: "He was cast in a strong and large mold, and had many of the personal traits of Washington, whom in his intellectual and moral character he greatly resembled." In 1851 he was detailed as instructor of artillery and cavalry at West Point, and while serving here was promoted to a captaincy. It was also during his residence here that he married Miss Frances L. Kellogg, of Troy. In 1855, while in California, he was appointed a major. In 1861 he was advanced to a colonelcy after the resignation of A. S. Johnston, Robert E. Lee, and W. J. Hardee, all of whom joined the Confederacy. General Thomas seems never to have wavered in his allegiance to the Union.

He was appointed brigadier general in 1861. He played an important part in the civil war, and his achievements in its various battles form most of the bulk of the book. He has been accused of being too slow and ponderous in his military manœuvres, but the biographer emphatically denies this and says that the foundation for these statements was derived from his great caution and clear-headedness in military matters. After the war he was appointed commander of the Military Division of the Pacific, where he served only a year, his death occurring suddenly in 1870 from apoplexy. This series has a double value for youthful readers, being really history, in the form of biographical story.

Continuous-current Dynamos and Motors; their Theory, Design, and Testing. By Frank P. Cox, B. S. New York: W. J. Johnston Co. (Limited), 1893. Pp. 271. Price, $2.

This is an elementary treatise on continuous-current dynamos and motors, which deals not only with the theories and laws governing their construction and action, but also with the application of these to their construction and running in the shop and power house. The first four chapters treat of the general principles of the machines, and serve as an introduction and preparation for the succeeding portions. Chapter V has to do with the mathematics of the magnetic circuit; and here the author has carefully abstained from using the higher mathematics and has only assumed for his student a knowledge of algebra and elementary geometry. Chapter VI deals with the theory of windings, losses, etc., and Chapter VII of the special features in motor designing. Chapters VIII, IX, and X relate to the practical application of the previously stated laws. In Chapters XI and XII, testing and handling the completed machine occupy the attention. The last two chapters deal with

the steam engine in its relation to electricity. There are four appendices on tests of irons, ampère turn tables, determination of sizes of wire for armatures and field coils, and on the calculation of belting.

Two German Giants: Frederick the Great and Bismarck. By John Lord, D. D., LL. D. New York: Fords, Howard & Hulbert, 1894. Pp. 173.

This is a brief account of the early years of these statesmen, followed by a consideration, more philosophical than historical, of their careers. Frederick the Great as the founder, and Bismarck as the builder, of the German Empire, are the aspects in which they appear, and while the author greatly admires their wonderful statesmanship and perseverance under the most overwhelming difficulties, he finds them both, and more especially Frederick, wanting in moral perception. He explains this by their absorbing ambition and love of country which led them to adopt that most dangerous of mottoes, that the end justifies the means. A character sketch of Bismarck by Bayard Taylor, written in 1887, is given, and also Bismarck's great speech on the enlargement of the German army in 1888. The book contains portraits of both Frederick and Bismarck.

Elementary Paleontology for Geological Students. By Henry Woods, B. A., F. G. S. New York: Macmillan & Co., 1893. Pp. 222.

This little book, which gives an elementary account of invertebrate paleontology, is one of a valuable series, the Cambridge Natural Science Manuals, which are edited by A. E. Shipley, M. A. The author has devoted most of his space to the treatment of those groups of fossil animals which are especially useful to the geologist, and but briefly considered those of interest mainly to the zoölogist. The author thus describes his method of treating the subject: "My plan has been to give, in each group, first an account of its general zoölogical features with a full description of the hard parts; secondly, the classification and characters of those genera which are important geologically; and, thirdly, a sketch of the present and past distribution of the group." For the use of those who wish to obtain a more extended knowledge of the subject, there is appended a list of some of the more important and easily accessible works on paleontology.

American Types of Animal Life. By St. George Mivart, F. R. S. Boston: Little, Brown & Co. Illustrated. Pp. 374. Price, $2.

A series of sketches of the various groups of animals which are either peculiar to America or have their most typical representatives here. It is intended to serve as an introduction to zoölogy, more particularly to the vertebrata, and more especially the mammalia. The first animals considered are the monkeys, to which thirty-five pages, containing several pictures, are devoted. The rarer and more striking forms are especially dealt with, and several amusing and instructive anecdotes related. Next comes the opossum, which is of peculiar interest to us, as it is a form of marsupial found only in America. It has been much studied by the zoölogist and geologist, because of its isolation from other marsupials, and is considered an important link in the evidence which connects the South American continent with Australia, as well as one of the many things indicating a close relationship between North America and the Europe of Tertiary times.

The turkey forms the subject of the third essay. He is so peculiarly an American institution, and, so far as we know, always has been, that, aside from his value as an edible, he deserves careful consideration. That this was appreciated so far back as Revolutionary times is shown by the fact that he was proposed as the national symbol by Franklin. The following extract is interesting in relation to the turkey's identification with holiday occasions:

"In 1566 twelve of these birds were presented to the French king Charles IX; and the first record of its appearance at a state banquet was at his wedding four year's later. Soon after that it seems to have become common in England, and already to have found its place as a family dish at Christmas dinners."

The next twenty-five pages are about the bullfrog and his relations. The author speaks of him as follows: "The frog has special claims to our gratitude and commiseration on account of all it has done and

suffered to increase our knowledge. In every physiological laboratory frogs are such ceaseless subjects of experiment that the animal may well be called the 'martyr of science.' What their legs can do without their bodies, what their bodies can do without their heads, what their arms can do without either head or trunk, what is the effect of the removal of their brains, how they can manage without their eyes, what effects result from all kinds of local irritations, from chokings, from poisonings, from mutilations the most varied: these are questions again and again answered practically for the instruction of youth."

The rattlesnake, "the exclusive possession of which will not excite the envy of other geographical regions," is next on the list. The serotine or Carolina bat is the representative of this family selected, because it is the only animal of this kind found in both the Old World and the New. The American bison gives the title to Chapter VII. It is of interest because of probable extinction in the near future. The raccoon, another peculiarly American product, is next selected as an introduction to the carnivores in general.

The sloth, the typical arboreal animal, is given thirty pages. "A marine animal and a quadruped" is studied in the sea lion in Chapter X. Whales and Mermaids is the title of Chapter XI. The last essay, entitled The Other Beasts, describes briefly the lemurs, rodents, and insect-eating animals, and then follows a recapitulation and summary of what has gone before. The book is extremely interesting, not only because of the good selection of individuals for description, but more, perhaps, because of Prof. Mivart's lively style, and his avoidance of anything which might be termed "dry." The book is well printed and nicely illustrated.

Dynamic Breathing and Harmonic Gymnastics. By Genevieve Stebbins. New York: Edgar S. Werner. Pp. 155.

This work is intended to set forth a peculiar system of combined mental and muscular calisthenics, part of which, at least, though perhaps of therapeutic value, seem unusually difficult. The following, entitled Yoga Breathing, occurs on page 86, and is a good example of the teaching of the book:

"1. Lie relaxed in an easy position. 2. Breathe strongly with vigorous vertical surging motion, with the same rhythm as in Exercise 1, which stretches the whole trunk like an accordion, and let the mind concentrate itself as follows:

"(*a*) Imagine the ingoing and outgoing breath drawn through the feet, as though the legs were hollow; (*b*) divert the same mental idea to the hands and arms; (*c*) to the knees; (*d*) to the elbows; (*e*) now breathe through the knees and elbows together. . . . (*l*) Complete this mental imagery, with breathing through the head and the whole organism in one grand surging influx of dynamic life."

And again, on page 2, under the heading Dynamic Breathing:

"To those, however, whose studies in life have enabled them to penetrate beneath or to rise above the bias of theological dogma on the one hand, and the speculative hypotheses of scientific schools upon the other, there will be no difficulty in reading between the lines of the present controversy between religion and science. . . ."

There are many other equally irrelevant passages in the book; and taken all together we do not see that it is likely to be of much service to the general reader. It contains a portrait of the author.

Ideale Welten in Wort und Bild (Ideal Worlds in Description and Picture). Ad. Bastian. 8vo. Three Parts. Pp. 791. Twenty-two Plates. Emil Felber, Berlin, 1892.

Adolphe Bastian, the Director of the Royal Ethnographic Museum at Berlin, is a veteran explorer, a wonderful collector, and an interesting writer. As the result of a journey to Farther India in 1890, we have this great work of nearly eight hundred pages—Ideale Welten. The book should particularly interest us, for the learned author has dedicated it to the Bureau of Ethnology in Washington and other ethnological workers throughout the Union, in memory of our celebration of the quadricentennial The work consists of three parts, separately titled and paged—Reisen auf der vorderindischen Halbinsel, Ethnologie und Geschichte, and Kosmogonien und Theogonien. They are a model to every one who would

make a journey productive to science. Few travelers know what things among any people are interesting to science; still fewer know how to get at them. Bastian goes to the heart of things, and although he gives much of general interest he aims particularly to secure knowledge of the philosophy and the religion of these Eastern peoples. Brahmanism and Buddhism are illuminated by his research, but it is particularly Jainism that he discusses. His work is undoubtedly a most important contribution to our knowledge of this curious religion. Twenty-two interesting plates, mostly copies of drawings or paintings made by Asiatics, give the Brahman, Buddhist, and Jainist ideas of heavens, earths, and hells.

Domestic Economy. By I. H. Mayer, M. D. Lancaster, Pa.: Published by the Author. Pp. 283.

This is a work on thrift in the household, rather disconnected, but containing much valuable information. It deals not only with the actual outlay, but also with the facts and behavior which determine and modify the necessity for outlay in special directions. Among the subjects discussed are: The Home—its location, both as regards sanitation and ready accessibility; Education; Recreation; Time—its use and misuse; Fuel; Clothing; Pets and Pests; Food; Drink; Mother and Child; Exercise; and Accidents.

Outlines of Forestry. By Edwin J. Houston, A. M. Philadelphia: J. B. Lippincott Co., 1893. Pp. 254. Price, $1.

The general conclusion seems to be that, unless something in the way of intelligent and ordered action is attempted toward the preservation of our forests, they will soon be things of the past, so far as commercial value is concerned, and that their destruction will profoundly modify the climate of large sections.

This interesting little book bears directly on the important question of the function of forests in determining climate, and the means of preserving and replacing them. It is a question which is of increasing importance in all countries as they advance in population and manufacture, and has been more or less under discussion in this country for some years past. In view of these facts, it becomes desirable that there should be not only concerted action between large landowners and the Government, under the supervision of especially qualified men, but also that each individual farmer shall appreciate the value of his "wood lot," not simply as a "wood pile," but also and even more *as* a "wood lot," as an important factor in determining, in common with those of his neighbors, the climate and fertility of the region, and hence indirectly his own and his neighbors' prosperity. The latter function is the one which this book is intended to fulfill; it is a primer of forestry. The first five chapters give a brief description of plant physiology and soil formation. These are followed by some pages on the forest's enemies and the forces tending to its destruction. Then comes a consideration of the effect of vegetation on rainfall, drainage, climate, and the purity of the atmosphere. These preliminary discussions are followed by a consideration of the methods by which a barren country may be timbered, or a section from which the forests have been removed may be retimbered. An appendix contains lists of trees suitable for replanting in different portions of the United States.

Inorganic Chemistry for Beginners. By Sir Henry Roscoe, F. R. S., assisted by Joseph Lunt, F. C. S. New York and London: Macmillan & Co. Pp. 241. Price, 75 cents.

In this little text-book Roscoe has treated the elementary principles of chemistry more fully than in his Elementary Lessons, while he has restricted the descriptions of elements and their compounds to a few typical examples. In the first portion of the book the basal principles of chemistry are taught in eight chapters or lessons, with the aid of carefully described experiments. At the end of each lesson is a summary under the heading "What we have learned," and a set of questions on the lesson. The rest of the volume is devoted to descriptions of selected elements and their compounds. Nonmetallic Inorganic Chemistry would be a more exact title for the book, as no metals are included among the elements described. There are a hundred and eight cuts of apparatus, etc. The chief characteristic of this text-book is that it boldly abandons the idea of covering

the whole ground, which most schoolbook writers cling to, and aims chiefly to impress the principles of the science upon the pupil's mind. Enough descriptive matter is used to illustrate these principles, but not so much as to obscure the main purpose of the book.

British Locomotives; their History, Construction, and Modern Development. By C. J. Bowen Cooke. New York: Macmillan & Co. Pp. 381. Illustrated. Price, $3.

The usual books on this and kindred subjects are either so technical as to be incomprehensible to the general reader, or so popular as to be of no considerable value to any one. Mr. Cooke has attempted to strike a happy medium, and while giving the mechanical construction and action of locomotives, accurately and in detail, he does so in untechnical language, and assists his text with carefully prepared drawings and diagrams. An idea of the scope of the work may be gathered from some of the chapter headings: Early History; Action of the Steam in the Cylinder; Valve Motion; The Boiler; General Details; How an Engine is put together; Classification of Engines; Brakes; Compound Locomotives; Combustion and Consumption of Fuel, and Engine Drivers and their Duties. The book is nicely printed and fully illustrated.

Text-book of Elementary Biology. By H. J. Campbell, M. D. New York: Macmillan & Co., 1893. Illustrated. Pp. 284. Price, $1.60.

This book belongs to the series of Introductory Science Text-books which this firm is now publishing, and is one of its most important volumes. The subject is one about which students should have something more than vague ideas; and yet, unfortunately, this is about the extent of their ordinary biological knowledge at the time of graduation. Biology lies at the root of human physiology, and this in turn should dictate that self-care and self-preservation upon which all our other actions in life depend. The scheme of the book is, first, a discourse on living as distinguished from non-living matter; followed by an examination into the properties and characteristics of protoplasm. Then the cell in its various forms, followed by a chapter on embryology. The tissues, both animal and vegetable, are next discussed; and finally there are several pages pointing out the differences between plants and animals, which sum up as follows:

"We have thus seen that there is no single attribute of animals which is not shared by some plants; and, on the other hand, there is no plant characteristic which is possessed by plants alone; hence it is necessary to allow that plants and animals are fundamentally identical, and, in fact, are only divisions of a single vital stock." An elementary examination follows of the forms of life usually considered in introductory text-books—the amœba, yeast plant, vorticella, tapeworm, leech, etc.

Dr. Campbell has given us a work well suited to beginners, and hence an important addition to our text-books on the subject. The book is well printed and illustrated.

A Review of the Systems of Ethics founded on the Theory of Evolution. By C. M. Williams. New York and London: Macmillan & Co. Pp. 581. Price, $2.60.

We have in this volume a substantial contribution to the literature of its subject. It consists of two parts, the first being a presentation of the most prominent systems of evolutionary ethics, under the names of their respective propounders, while the second is a general examination of the whole field. The authors whose views are set forth are Darwin, Wallace, Haeckel, Spencer, Fiske, Rolph, Barratt, Stephen, Carneri, Höffding, Gizycki, Alexander, and Ree. Mr. Williams must be a hero-worshiper who sees all wisdom in Darwin, else he would not have lugged in the great biologist's name at the head of this list. He calls Darwin "the first laborer in this line," and says that "a review of evolutional ethics must, therefore, in order to start with the proper origin of the science, begin with Charles Darwin." He gets together ten pages of extracts from Darwin's works, the first four pages of which relate to nothing but instinct and heredity. These are from the Origin of Species, which appeared in 1859, and the essay on Instinct prepared for that work, but not published till after Darwin's death. Then follow quotations from the Descent of Man, some of which do relate to ethics, but the date when

that book appeared (1871) is much too late to be taken as "the proper origin of the science." Quotations from A. R. Wallace beginning in 1871 come next, and are followed by some from Haeckel beginning in 1874. Having thus examined the theories of what our author calls "the great original authorities," he proceeds with "writers who have turned these theories to account and elaborated them." In this second group of writers he places Herbert Spencer first, and says, "In treating of Mr. Spencer's work, it is necessary to begin with a book which made its appearance before the publication of the Origin of Species, namely, Social Statics (1851)." Mr. Williams's designation of Darwin as "the first laborer in this line" needs no further comment. The views of Spencer are then presented as found in his Social Statics (both the 1851 and the recently revised edition), his Collected Essays, The Man *versus* the State, The Principles of Psychology, the several divisions of The Principles of Ethics, and one or two minor writings. By letting Spencer speak for himself in quotations our author secures a nearly correct representation of his ethical theory, but he states that Spencer in the original Social Statics "advocates the nationalization of land," and neglects to say that Spencer has since repeatedly abjured this doctrine, and leaves nothing in the revised edition that can be construed as supporting it. More space is found needful for Spencer, forty-eight pages, than for any other writer represented. John Fiske is taken up next, and the theories of the other authors noticed follow in the order in which they are named above.

The treatise which forms the second part of this work is one in which a wealth of data has been used, and a highly instructive and suggestive result has been attained. The author begins by examining the operation of heredity and variation in evolution, and passes next to a consideration of intelligence and "end." Among the other topics considered are the mutual relations of thought, feeling, and will in evolution, egoism, altruism, and conscience. There is an interesting chapter on The Moral Progress of the Human Species as shown by History, in which the morals of ancient Greece and Rome and mediæval England are shown to have been far below modern standards. In the closing chapter, on attainment of the ideal, the author touches upon a variety of considerations, and ends with some helpful words on the transition from the belief in a personal immortality to the expectation of persisting after death only as an influence upon those remaining in life.

So valuable a book should not have been issued without an index.

On the Old Frontier, or the Last Raid of the Iroquois. By William O. Stoddard. Pp. 340. Price, $1.50. New York: D. Appleton & Co.

This is a novel dealing with frontier life in Revolutionary times, when most of the fighting men were with Washington in the East, and the frontiers were therefore very weakly garrisoned. It describes the motives and nature of a raid by the Indians on a settlement known as Plum Creek.

The hero is a boy, who was stolen by the Indians when very young and brought up among them. He finally escapes and makes his way to Plum Creek, where he is adopted by the gunsmith of the settlement. He is able, by reason of his Indian training, to render valuable assistance to the settlers during the skirmishes preceding the concentrated attack, and just at the last, when the fort is about to fall into the hands of the Indians, he appears with a detachment of United States troops and saves its inmates, besides giving the death blow to the Indian raids. He then discovers a relative in the commanding officer of the soldiers, and learns that his family, which he had supposed were massacred at the time of his abduction, are alive, and mourning *his* early demise. The characters speak in dialect, and the book is well illustrated.

The story is "a fiction founded on fact."

After an interval of seven years the first volume of the *History of the Theory of Elasticity*, by the late *Isaac Todhunter*, has been followed by the two parts of Volume II (Macmillan, $7.50). The manuscript that Dr. Todhunter left has been edited and completed by Prof. *Karl Pearson*, the physical and technical branches of the subject being wholly the work of the editor, likewise the general history of the subject after the date

at which Dr. Todhunter left it. The present volume covers the period from Saint-Venant to Lord Kelvin. It carries the analysis of individual memoirs completely to the year 1860, but after that point the editor has found it practicable to deal with the work of certain elasticians only. These are the two just named, with Boussinesq, Rankine, F. Neumann, Kirchhoff, and Clebsch. Although the part since 1860 is only the framework of what Prof. Pearson hoped to make it, the work is a monumental one. The number of the memoirs included in the thirteen hundred pages of the second volume by no means measures the work expended upon this part of the history. The study and analysis of many other memoirs were involved in the task. A systematic index, carefully prepared by Prof. Pearson, is appended.

We have received Part I (Kinematics) and Part II (Dynamics and Statics) of *An Elementary Treatise on Theoretical Mechanics*, by Prof. *Alexander Ziwet*, of the University of Michigan (Macmillan, $2.25 a volume). The work owes its existence mainly to the difficulty of finding a good modern text-book suited to the requirements of the American student. While it is intended first of all as an introduction to the science of theoretical mechanics, the author has aimed to make it serve as a preparation for the applications in engineering practice, and to bring out the utility of the purely mathematical training. To keep the whole work within reasonable bounds, the more advanced parts of the subject had to be strictly excluded. A third part (Kinetics) will complete the treatise.

The Book of the Fair, published by the Bancroft Company, Chicago and San Francisco, is intended to reproduce and preserve, by engraving and letterpress, all the characteristic features of the recent exposition at Chicago. The publishers claim that it is the only work attempting to reproduce the exposition in this way entire. "It confines itself," they say, "neither to art alone on the one side nor to dry statistics on the other, but aims to present in attractive and accurate form the whole realm of art, industry, science, and learning, as here exhibited by the nations, so far as can be done within reasonable limits." The work will consist of one thousand pages of twelve by sixteen inches, will be issued in twenty-five parts of forty pages each, at the price of a dollar a part, and will contaiu more than a thousand illustrations, many of them full page.

In *J. E. Mulholland's* revision of Dr. Arnold's *First and Second Latin Book and Practical Grammar* the labors of the editor have been directed, first, to the removal of all errors; second, to a change of exceptional Latin expressions, which are declared out of place in an elementary work; third, to simplicity of design, so that subjects should not be prematurely thrust upon the attention of the pupils; and, fourth, to a more consistent arrangement of the parts of the Second Book. In the revision of Arnold's *Practical Introduction to Latin Prose Composition*, by the same editor, the matter on the Sequence of Tenses, hitherto scattered throughout the work, has, by means of references, been unified, and that on Conditional Propositions has, by the removal of much verbiage and some errors, been arranged so as to be comprehensible to the ordinary student. Also, whereas in the old book reference was merely made to certain works on Synonyms, in this edition, the works quoted not being commonly in the hands of pupils, the proper word is given. (Both of these books are published by the American Book Company. Price, $1 each.)

The *Inductive Greek Primer* of Drs. *W. R. Harper* and *C. F. Castle* is designed for a beginner's Greek book and to meet the wants of younger pupils as well as of those for whom the *Method* is adapted. It differs from the *Method* in that the lessons are shorter; the notes are more copious and elementary; the exercises are simple; the pupil's knowledge of Latin grammar is drawn upon to illustrate and facilitate his knowledge of Greek grammar; the pupil is taught to read Greek in the order of the original; the first occurrence of words is specially indicated in both the text and the vocabulary. The volume articulates with the Greek Prose Composition of the same authors. (American Book Company. Price, $1.25.)

In a book entitled *The Gospel of Paul*, the author, *Charles Carroll Everett*, Professor of Philosophy in Harvard Divinity School, presents an interpretation of Paul's doctrine of the atonement which he believes to be new; not a theory of his own "of a possi-

ble scheme of atonement, to which some of Paul's words may be made to fit more or less loosely. I mean a statement which has nothing in it of my own, but which is based wholly upon an examination of the words of Paul, these being taken in their most natural and direct signification." This interpretation forced itself upon him when he first began the serious reading of the New Testament, and all his subsequent study has confirmed its truth; and while it is remote from our habits of thought, it does not, the author believes, contradict our moral sense, and he hopes it "may do something to reconcile the New Testament and the conscience of the Christian world." (Published by Houghton, Mifflin & Co. Price, $1.50.)

The edition of the *Æneid (six books) and Bucolics of Vergil* prepared by President *W. R. Harper* and Instructor *F. J. Miller* is intended to present the Latinity of the author in as suggestive and accessible a form as possible, and to afford stimulus and material for the study of the poet from a literary point of view. The plan of the studies is inductive throughout. In the Introduction are given a series of studies for developing important principles of syntax, and a new presentation of the Vergilian verse and principles of quantity. Materials for literary study are provided in a bibliography; a list of topics for investigation; an account of the Royal House of Troy; Rhetorical Study; and notes of various kinds. The Eclogues are introduced at the request of teachers who desire to give their classes more than the first six books of the Æneid. (This edition of Vergil is published by the American Book Company. Price, $1.50.)

President *W. R. Harper*, of the University of Chicago, and *James Wallace* have prepared a handsome, compact edition of Xenophon's Anabasis for class-room use, with suitable illustrations and other aids to enhance interest and facilitate the study of the noble classic. The text is that of the recension of Arnold Hug. The notes are brief and elementary, supplemented by references to the grammars and to the historical introduction which precedes the text. The first occurrence of words is indicated by special type. Great pains have been taken with the vocabulary. Guides are furnished for etymological study. Maps of Greece and of the route of the Anabasis and the retreat are inserted. Three of the books have been edited for sight-reading. Tables of paradigms are given. The Historical Introduction, Bibliography, and Itinerary are rich in information and can not but contribute much to make the story seem real. (American Book Company. Price, $1.50.)

For his book of *Logarithmic Tables*, Prof. *George William Jones*, of Cornell University, has compared the figures of the principal larger tables, and applied every known test for accuracy, computing anew where there was doubt; has sought, by similar examinations of standard tables and by consultation, to secure a plan that would promote rapid and easy use; has employed such type and adopted such arrangement as would so far as possible prevent straining of the eyes; and presents the work at the small cost of seventy-five cents. The tables are preceded by a satisfactory set of explanations, and include logarithms of numbers, trigonometric functions, addition-subtraction logarithms, prime and composite numbers, squares, cubes, square and cube roots, reciprocals, quarter-squares, Bessel's coefficients, binomial coefficients, and errors of observation. (Published by the author at Ithaca, N. Y., and by Macmillan & Co.)

PUBLICATIONS RECEIVED.

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Badenoch, L. N. Romance of the Insect World. New York: Macmill n & Co. Pp. 341. $1.25.

Bell, Alexander Melville. Speech Tones. Washington, D. C. Pp. 18.

Bolin, Jakob, New York. Mental Growth through Physical Education. Pp. 18.

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Cattell, J. McKeon, and Baldwin, J. Mark. The Psychological Review. Bi-monthly. Vol. I, No. 1. Pp. 112. New York: Macmillan & Co. 75 cents; $4 a year.

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Hitchcock, Romeyn. The Ancient Pit Dwellers of Yezo, Japan. Pp. 10.—The Ainos of Yezo. Pp. 75.—Shinto, or the Mythology of the Japanese. Pp. 14.—Ancient Burial Mounds of Japan. Pp. 16, with Plates.—Some Ancient Relics in Japan. Pp. 2, with Plates. All published at the United States National Museum.

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Huxley, Thomas H. Method and Results. Pp. 430.—Science and Education. Pp. 451. New York: D. Appleton & Co. $1.75 each.

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University of Pennsylvania. Contributions to the Botanical Laboratory. Pp. 125, with Plates.

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POPULAR MISCELLANY.

Geological Society of America.—The sixth annual meeting of the Geological Society of America was held December 27–29, 1893, in Boston and Cambridge, Mass. The sessions of the opening and closing days were in the hall of the Boston Society of Natural History, and those of the second day were in the Harvard University Museum, Cambridge. The Geological Society has a membership of about two hundred and twenty-five, comprising most of the prominent working geologists of North America. It holds two meetings yearly, one in the summer in connection with the American Association for the Advancement of Science, and a winter meeting in the holidays following Christmas. Each of these meetings is held successively in different cities of the United States and Canada, previous winter meetings having been held in New York, Washington, Columbus, and Ottawa. The officers elected for the year 1894 are Prof. T. C. Chamberlin, of Chicago, president; Prof. N. S. Shaler, of Cambridge,

and Prof. George H. Williams, of Baltimore, vice-presidents; and Prof. H. L. Fairchild, of Rochester, N. Y., secretary. About sixty papers were presented at this meeting, a few of which are here briefly noticed:

In his address as the retiring president, Sir J. William Dawson, of Montreal, chose for his subject Some Recent Discussions in Geology, considering especially the building up and development of the continents. He noted the controversies respecting the age of the older crystalline rocks, the true foundation stones of continents, instancing those of the Highlands of Scotland as described by Geikie, and the older rocks of North America as worked out by Logan and his successors. He was inclined to think that the oldest rocks that we shall know are the gneisses of the lower Laurentian, and that these may be regarded as the igneo-aqueous products of the earliest action of the waters on the crust of a cooling globe. He then referred to the rival theories of mountain-building, and, after distinguishing between mountains of eruption (volcanoes), like Vesuvius and Cotopaxi, mountains of slightly inclined strata, like the Lebanon and the Sierra Nevada, and mountains of contorted strata, like the Alps and the Appalachians, noted the diverse views as to the origin of the latter. He favored the time-honored contraction theory as explained recently by Le Conte, but saw no objection to connecting with this the deposition theory of Hall and others, the expansion theory of Mellard Reade, and the isostatic theory of Dutton. When it is necessary to account for the compression of vast masses of rock into a third of their normal dimensions and for their elevation thousands of feet above the level of the sea, we may be thankful to invoke all available powers each in its proper place, and the sculpturing due to atmospheric agencies besides.

Prof. C. H. Hitchcock, of Hanover, N. H., spoke about Ancient Eruptive Rocks in the White Mountains. He said that in his reports of the New Hampshire Geological Survey he had described in detail a great variety of granites occurring in the White Mountains, without having discovered the principle of their association. He then reviewed the order of these varied igneous rocks and showed that the same structure found in volcanoes appeared in the White Mountains. He was therefore convinced that the granites were truly eruptive. If the modern view of the formation of granite is correct, the depth at which it is formed, as shown in the White Mountain region, is from two thousand to five thousand feet, and decidedly not forty thousand feet, as some geologists have maintained.

Prof. George H. Williams, of Johns Hopkins University, treated the subject of Ancient Volcanic Rocks along the Eastern Border of North America. He proposed to designate as volcanic only such igneous rocks as had flowed up through vents to the surface. All existing knowledge of the occurrence of these rocks during the early geologic ages in eastern North America was summarized, beginning with Newfoundland and passing southwestward along the Appalachian mountain belt.

Mr. Alexander Agassiz, Director of the Museum of Comparative Zoölogy at Harvard University, presented An Account of an Expedition to the Bahamas, which were described as formed of wave-worn and wind-blown coral sands.

Among the papers relating to the glacial drift, Prof. T. C. Chamberlin and Mr. Frank Leverett discussed Certain Features of the Past Drainage Systems of the Upper Ohio Basin, concluding that the lower portions of the rock valleys of the upper Ohio and its tributaries were eroded during an interglacial epoch. Prof. G. Frederick Wright, describing parts of the same region in a paper on the Glacial History of Western Pennsylvania, referred the valley erosion in rock almost wholly to a preglacial time of higher altitude of the country, citing the occurrence of glacial gravel deposits extending from the high terraces down to the bottom lands, and regarding the Ice age as continuous and geologically short.

The Harvard Observatory.—The beginning of the Astronomical Observatory of Harvard College is usually identified with the appointment of Prof. W. C. Bond as observer in 1840. The appearance of the first comet of 1843 excited fresh interest in the subject, and funds were collected to buy the great telescope, which then had only one match in the world, in 1847. The resources of the observatory have since been increased by various subscriptions, gifts, and bequests. The

general expenses are largely provided for from the bequests of Edward B. Phillips and Robert Treat Paine. The Henry Draper Memorial, established by Mrs. Draper, furnishes the means of studying the spectra and other physical properties of the stars. The observing station near Arequipa, Peru, 8,050 feet above the sea, was established under the bequest of Uriah A. Boyden. By maintaining a station south of the equator, work at Cambridge may be extended to the southern stars; and all important researches there are, therefore, now made to include stars in all parts of the sky, from the north to the south pole. Miss C. W. Bruce, of New York, has provided the means for a photographic telescope, which will be mounted first in Cambridge, and later in Peru. In meteorological work the observatory is associated with the Blue Hill Meteorological Observatory, the New England Meteorological Society, and the New England Weather Bureau, and provides for the publication in its annals of the results obtained by the observers of these associated stations. Meteorological stations connected with the observatory at Arequipa, Peru, are situated on Mount Chachani, 16,650 feet, and on El Misti, 19,200 feet, above the sea. Several large prisms have been procured for photographing the spectra of the stars.

Women in Postal and Railway Service.—According to the *Journal des Economistes*, France was the first country to admit women to places in the postal administration, and their engagement has proved so satisfactory that the authorities are inclined to prefer them to men wherever it is possible. In the United Kingdom, deducting the letter carriers, 25·2 per cent of the persons employed in the post offices are women. In Switzerland women are eligible equally with men for vacancies in the postal and railway departments. Many women are engaged in the telegraph and telephone departments, and the railways employ them in various capacities. In Holland only eight classes of employment in the administration of posts and telegraphs are open to women. The railways employ seven hundred and twenty women. In Italy a few women are occupied in the postal and telegraph offices. In Spain nearly all the positions in the telephone offices are held by women, and their work in the telegraph offices has been so satisfactory that the Government has decided to have more of it. In Sweden more women than men are found in the telegraph offices, and single women are admitted to all departments of the post-office service, except that of letter carriers. Women have the same salaries and equal positions in the telegraph and post offices of Norway and Denmark as men, and in Denmark may become "station masters" on the railway, while they also figure as shorthand writers in the Parliament. We find them also in public offices, on the most liberal terms that have been made, in Finland and Iceland. They occupy many positions in Germany, Austria, Roumania, Russia, and in the British colonies. The Republic of Brazil admits women to all the Government departments; the United States of Colombia has provided a class in telegraphy for them; and in Chili, besides filling places in the postal and telegraph departments, they monopolize the function of conductors on the tramways.

The Russian Village.—While the dissolution of the community of land in western Europe is of comparatively recent date, in Russia, as Mr. Isaac A. Hourwich shows in his Columbia College study of the Economics of a Russian Village, the process of evolution has been less rapid, and this primeval institution has been preserved till to-day. There is not, however, found there within historical times that tribal communism which Mr. Lewis H. Morgan met with among North American Indians. The Russian village community of historical times consists of a number of large families, often, yet not necessarily, of common ancestry, who possess the soil in common, but cultivate it by households. The ancient communal co-operation reappears sporadically, on various special occasions, in the form of the *pómoch* (or help). Some householder invites his neighbors to help him in a certain work (just as in the times of our early settlements)—to mow his meadow lot, to reap his field, to cut down wood for a new house he has undertaken to build, etc. This is regarded as a reception tendered by the family to its neighbors, and different kinds of refreshments are prepared for the occasion, which constitute the only remuneration for the work done by

the guests. Of course, there is nothing compulsory in the custom, and no one is bound to answer the call in case he does not like to do so. On the other hand, the party benefited is under an obligation to appear at the call of those who participated in the *pómoch*. This custom does not play as conspicuous a part as in former days, when rural settlements were scattered clearings in the forests, and pioneer work was constantly needed. Still, even then it was only a social revival, hinting at a preceding epoch of closer communistic co-operation, and at the same time pointing out the existing severance between the households of which the community was formed. The Russian family is not identical with the Roman family, in which the *paterfamilias* was absolute master, or of any of its derivatives. It is a union of individuals having their individual rights recognized by the law, though sometimes not without certain limitations in favor of the head of the family. It is a perfect communistic commonwealth. All the movables belonging to the household, as well as its whole income, constitute the collective property of the family, but not of its head. The old Russian family resembled a community even in the number of its members. One described by Mr. Krasnoperoff numbered ninety-nine members, and was composed of a grandmother with her children and married grandchildren, all of whom were living together and working for their own common benefit. Such households, exceptions now, were universal in the past. Thus ownership of land by the community without, and complete communism within the family, were the fundamental elements in the structure of the village at the dawn of Russian history.

Chinese "Letter Shops."—According to the United States consul at Fu Chau, the Chinese Government has not yet established any post offices or postal system for the masses of the people; yet communication is easy between the people in all parts of the empire through private enterprise, which has established what are called "letter shops." Official dispatches are carried by couriers, at a rate so rapid, in cases of emergency, as from two hundred to two hundred and fifty miles a day. These official couriers are not allowed to convey private dispatches. At the treaty ports "letter shops" are used by the natives only; but in the interior, or at places not reached by the foreign postal arrangements, they are employed by foreigners as well, chiefly by missionaries. All letters and parcels to be sent may be registered and insured. When given in at a "letter shop," the contents of the envelope are displayed before it is sealed up, and stamped with the "chop" of the shop. Charges for the transmission of valuables are made on a percentage of declared value, and, as with letters, differ according to the distance to which the package is to be carried. A receipt is given, and the shopkeeper then becomes responsible either for its safe delivery, with unbroken "chop" or seal, at its destination, or for its return to the sender. In some parts of the empire about two thirds of the expenses of transmission are paid by the sender, while the remainder is collected from the receiver; thus the shop is secured against entire loss from transient customers, and the sender has some guarantee that his letter will be carried with dispatch. There are said to be nearly two hundred letter shops in Shanghai, but in many remote villages there are none.

Protection of Birds' Eggs.—A short discussion took place in the British Association concerning the best method of protecting birds' eggs. In presenting the report of the committee on the subject, Dr. Vachell said that, while everybody agreed that eggs should be protected, serious differences of opinion prevailed as to the way in which the object should be reached. Some thought the taking of particular eggs in particular places should be prevented at particular times of the year. Against this, it had been found impossible, on account of resemblances, to prove in court the specific identity of many kinds of eggs. It had therefore been suggested, as a better plan, to protect the special areas in which particular species were found to be declining. The question was asked, What was to be done with the little boy ten years old who might be tempted to rob a nest? Was he to be sent to jail? Mr. Walter found bird-nesting an intolerable nuisance, eggs being collected, not for scientific purposes, but simply to ornament rooms. Mr. M. S. Pemberry argued that many boys

began a study of natural history by the collection of eggs. Mr. Milne Redhead did not think the act of bird-nesting the greatest evil, but the collection of eggs for sale in large towns. Prof. Newton spoke of the practical impossibility of convicting bird-nesters on account of the difficulty of distinguishing between the eggs of one species and those of another.

Various Speeds.—The horse, said Mr. Jeremiah Head, in a paper recently read, though he could not walk faster than man, nor exceed him in jumping heights or distances, could certainly beat him altogether when galloping or trotting. A mile had been galloped in one hundred and three seconds, equal to thirty-five miles per hour, and had been trotted in one hundred and twenty-four seconds, equal to twenty-nine miles per hour. How man's position as a competitor with other animals in speed was affected by his use of mechanical aids, but without any extraneous motive power, was considered in reference to locomotion on land, in water, and in air. But the most wonderful increase in the locomotive power of man on land was obtained by the use of the modern cycle. One mile had been cycled at the rate of 27·1 miles per hour, fifty at twenty, one hundred at 16·6, three hundred and eighty-eight at 12·5, and nine hundred at 12·43 miles per hour. Unaided by mechanism man had shown himself able to swim for short distances at the rate of three, and long distances (twenty-two miles) at the rate of one mile per hour. He had also given instances of being able to remain under water for four and a half minutes. Credible eye-witnesses stated that porpoises easily overtook and kept pace with a steamer going twelve and a half knots, or, say, over fourteen miles an hour, for an indefinite length of time. This was five and fifteen times the maximum swimming speed of a man for short and long distances respectively.

Tendencies of Population.—In a paper read in the British Association, Mr. E. Cannan, of Oxford, sought to show that, contrary to the general belief that the population of the great towns is being increased almost as much by immigration as by excess of births over deaths, the excess of immigrants over emigrants, or net immigration, is rapidly diminishing, and seems likely to disappear before the end of the century. The net immigration into London in the last ten years was only fifty-six per cent of what it was in the previous ten years, and only sixty-three per cent of what it was thirty years before, when the population was two and a half millions less than it is now. In this matter London is by no means in advance of the other great towns. In Liverpool the net immigration was 68,000 in 1851 to 1860, 56,000 in 1861 to 1870, 49,000 in 1871 to 1880, but in 1881 to 1890 the balance was the other way, and there was a net emigration of 15,000. In the case of Manchester the decline of the net immigration was neither so continuous nor so great as in Liverpool, but it was considerable. In each of the first two decades it was about 32,000, then it rose to nearly 50,000, but in the last decade it has declined to 17,700. The three great Yorkshire towns, Leeds, Sheffield, and Bradford, showed considerable fluctuations. Into the three taken together the net immigration was 25,000 in 1851 to 1860; in 1861 to 1870 it made an enormous jump up to 78,000, and then dropped right down to 18,000 in 1881 to 1890. The net immigration into the towns was affected by migration between the towns and other countries as well as by migration between the towns and the rest of England and Wales.

Animal and Artificial Mechanism.—Comparing animal mechanism with artificial, Mr. Jeremiah Head said, in his sectional address at the British Association, that all animals were in their bodily frames, and in the intricate processes and functions which went on continuously therein, mechanisms of so elaborate a kind that we could only look and wonder and strive to imitate them a little here and there. The mechanical nomenclature of all languages was largely derived from the bodies of men and other animals. Many of our principal mechanical devices had pre-existed in them. Mr. Head proceeded to consider how far man was in his natural condition, and had become by the aid of mechanical science, able to compete successfully with other and specially endowed animals, each in his own sphere of action. The bodily frame of man was adapted for life and movement

only on or near to the surface of the earth. Without mechanical aids he could walk for several hours at a speed which was ordinarily from three to four miles per hour. Under exceptional circumstances he had accomplished over eight miles in one hour, and an average of two and three quarter miles per hour for a hundred and forty-one hours. In running he had covered about eleven and a half miles in an hour. The power of the living human mechanism to withstand widely diverse and excessive strains was altogether unapproachable in artificial constructions. Thus, although fitted for an external atmospheric pressure of about fifteen pounds per square inch, he had been able, as exemplified by Messrs. Glaisher and Coxwell in 1862, to ascend to a height of seven miles and breathe air at a pressure of only three and a half pounds per square inch, and still live. And, on the other hand, divers had been down eighty feet deep, entailing an extra pressure of about thirty-six pounds per square inch, and had returned safely. One had even been to a depth of one hundred and fifty feet, but the resulting pressure of sixty-seven pounds per square inch cost him his life. No animal burrowed downward into the earth to a greater depth than eight feet, and then only in dry ground.

The Phillips Prize Essay Fund.—The Herbert M. Phillips prize essay fund of five thousand dollars of the American Philosophical Society was founded by Miss Emily Phillips in memory of her deceased brother, who was an honored member of the society. Its purpose is the provision of prizes, to be awarded from time to time from the income of the fund, for the best essay of real merit on the science and philosophy of jurisprudence. In pursuance of the conditions of its establishment, a prize is now offered by the society, to be awarded during 1895, of five hundred dollars lawful gold coin for the best essay on either of the following subjects: 1. The sources, formation, and development of what is generally designated the common law of England. 2. The theory of the state, treated historically, and upon principle, with a discussion of the various schools of classical, mediæval, and modern thought upon the subject. 3. The historical and doctrinal relations of the Roman law and the English law, illustrated by parallels and contrasts. The essays of competitors should be in possession of the society before the first day of January, 1895, and should be sent addressed to Frederick Fraley, president of the society.

Oxygen as a Remedy for Choke Damp.—A committee appointed at the Edinburgh meeting of the British Association, 1892, to determine whether oxygen gas was useful as a restorative in cases of carbonic-acid poisoning, and particularly in those of choke-damp asphyxia in mines, reported to the recent meeting its conclusions, from experiments on rabbits, that oxygen was of no greater service than air. It suggested, however, that the experiment of keeping a few cylinders of air with nose and mouth pieces ready for use in those parts of the workings where men could be most easily imprisoned might be attended with valuable results. It seemed quite reasonable that where a person had to be dragged long distances through a contaminated atmosphere the chances of ultimate recovery would be greater if the effects of this poisonous atmosphere were neutralized at the commencement and during the progress of the work of rescue than if no such attempt were made until fresh air was reached in the ordinary way.

Isolation of Fluorine.—A demonstration of the isolation of fluorine was made before the British Association by Dr. Meslans, the representative of the French chemist, M. H. Moissan. The apparatus employed consists entirely of platinum and fluorspar. A powerful current of electricity is passed between platinum electrodes through anhydrous liquid hydrogen fluoride mixed with one of its salts, and cooled to a very low temperature by means of methyl chloride. Under these conditions fluorine is given off from one of the electrodes, and hydrogen gas from the other. The fluorine is an almost colorless gas, and its presence is made evident by its action on various compounds. Crystallized silicon, amorphous boron, phosphorus, sulphur, alcohol, and various metals take fire at the ordinary temperature and burn brilliantly in a current of the gas. These phenomena were exhibited to the section, and the demonstration was in every way success-

ful. Sir Henry Roscoe moved a vote of thanks to M. Moissan and M. Meslans. The vote, he said, must be regarded as coming from the whole Association and not simply from the Chemical Section. Prof. T. E. Thorpe seconded the motion, which was carried with loud cheers, and the president of the section, Dr. Emerson Reynolds, sent a telegram to M. Moissan congratulating him, on behalf of the section, on the great success of the demonstration.

Bacteriology in Chemistry.—Bacteriology, said Prof. Frankland, opening the discussion of that subject in the British Association, although originally an offshoot of botany, received its great impulse from the association with chemistry which began with the researches of Pasteur, while the greater part of our more recent knowledge was due to the labors of those medical men who had followed in the steps of Koch and his pupils. The progress that has been made of late years in this line of research was mainly due to the methods of producing pure and selective cultivations. These methods did not at present seem capable of any great modification, and a knowledge of them might be regarded as essential in a really liberal education. Pure cultivations of yeasts were now articles of commerce, and pure cultivations of microbes for purposes of research could be obtained in the same manner as pure chemicals. Bacteria, whose properties had been modified by successive cultivations, are also supplied in quantities for the preventive inoculation of cattle. Later work had shown that the differentiation of even the most carefully studied bacteria, such as those of cholera and typhoid, was very difficult, and the morphological characteristics which were originally employed almost exclusively had given way to chemical and pathogenic tests. Individuals of the same bacterium under different conditions will show greater variations than are shown by different species. The fermentations produced by bacteria, as distinct from those produced by yeasts, were of constantly increasing importance, and had afforded means of splitting up certain compounds and isolating new products that could not be obtained in any other way. The compounds fermentable in this way belonged to a very few chemical groups, and the products of the change were few in number and comparatively simple in character. It would seem that while the same compound might yield different products when acted upon by different organisms, one and the same organism would yield the same products even when it acted on substances of very different composition. By reason of their selective action and their tendency to attack certain compounds in preference to others in the same liquid, bacteria enabled us to separate substances of identical chemical composition but different physical properties which could not as yet be separated in any other way.

Arctic Rivers.—The rivers which flow into the Arctic Ocean, said Mr. Henry Seebohm in the British Association, are some of them among the greatest in the world. Some idea of the relative sizes of the drainage areas of a few of the best-known rivers may be learned from the following, in which the Thames, with a drainage area of 6,000 square miles, is the unit: Nine Thames equal one Elbe (54,000); two Elbes equal one Pechora (108,000); two and a half Pechoras equal one Danube (270,000); two Danubes equal one Mackenzie (540,000); two Mackenzies equal one Yenisei (1,080,000); two Yeniseis equal one Amazon (2,160,000). There is nothing that makes a greater impression upon the arctic traveler than the enormous width of the rivers. The Pechora is only a river of the fifth magnitude, but it is more than a mile wide for several hundred miles of its course. The Yenisei is more than three miles wide for at least a thousand miles and a mile wide for nearly another thousand. Whymper describes the Yukon as varying from one to four miles in width for three or four hundred miles of its length. The Mackenzie is described as averaging a mile in width for more than a thousand miles, with occasional expansions for long distances to twice that size.

Investigation of Earthquake Phenomena.—The committee of the British Association, appointed to investigate the volcanic and earthquake phenomena of Japan, has reported that the records of horizontal pen-

dulum motions during the past ten years show that the earth tremors of Japan have no direct relation to its earthquakes. Records of both have been kept. A well-marked periodic tilt of the land has been detected, corresponding to a rise of the land on the northeast side, and a more rapid subsidence of it again. Similar effects had been recorded in Germany, but of much smaller amplitude. In Germany, barometric changes caused the tilting, but the relation between the two was not so marked in Japan; there may possibly, however, be some connection of them with magnetic influences. The directions of earthquake motions and of earth tremors across Japan were each at right angles to the mountain axis of the country, a fact which suggests that both are caused by crumpling of the mountains round their axis. The observations of earth tremors had gone so far as to demand attention from practical astronomers and others. When a tremor occurred it rendered delicate weighing impossible, inasmuch as the balance swung irregularly and altered its zero. Similarly astronomical observations would be upset. A practical outcome of the committee's reports was the alteration in the design of bridges in Japan. After earthquakes it was found that bridges and other masonry gave way at the base; the form of a wall or pier had been calculated which, on being subjected to a horizontal reciprocating medium, would be equally likely to break at any part.

Mount Tacoma.—An effort is making by the citizens of Tacoma, Washington, to restore to their lofty and graceful mountain—to which the name Rainier has been attached—its aboriginal designation of Tacoma. This term, according to the analysis of it by the Hon. James Wickersham, quoted in F. G. Plummer's Illustrated Guide Book, means "snow-covered mountain." The mountain is in full view from the city of Tacoma, bearing south, 56° east, a distance of forty-four miles. It stands about twelve miles west of the Cascade Range, and its entire drainage flows westward into Puget Sound and the Columbia River. It "has the form of a dome surmounted by three small peaks, with a maximum elevation of fifteen thousand feet. It rises almost from the sea-level; and as its average diameter at the base is about twenty miles, its mass is roughly estimated at two hundred cubic miles. Upon its slopes on every side are enormous glaciers and ice-fields, arranged on radial lines and forming a system that for extent and grandeur is unexcelled on the earth. The limit of perpetual snow is at four thousand feet, but the timber line extends much higher. Natural groves, meadows, and prairies surround the mountain, except where the river cañons and glaciers cut the slopes. Upon the northeast the Urania, Blaine, Inter, and Winthrop glaciers drain into White River and thence to Duwamish Bay. To the northeast the Carbon, Willis, North Mowich, South Mowich, and Pugallup glaciers form the Pugallup River, which flows to Tacoma harbor. To the southwest the Tahoma, Kautz, Van Trump, Nisqually, and Paradise glaciers drain into the Nisqually River, which flows through Succotash Valley to Puget Sound. The Cowlitz River is the drainage from the Cowlitz, Willinakas, and Little Willinakas glaciers, and flows into the Columbia River." The mountain is reached from Tacoma by electric railway, eleven miles to Lake Park, stages to Paradise Park, sixty-seven miles from the city, and thence by a day's hard work climbing nine thousand feet up in seven miles. Mr. Plummer's Guide Book (Tacoma, Wash.) is full of information about the mountain, clearly and precisely given.

Dr. Alfred L. Carroll.—Dr. Alfred Ludlow Carroll, of New York, who died October 30, 1893, was a physician of high standing, a vigorous writer on subjects of medicine, sanitation, and hygiene, and an active laborer for the elevation of the standards of medical science and practice and the diffusion of sound principles of hygiene. A full sketch of his life has been prepared by Dr. J. W. S. Gouley for the New York State Medical Association, from the advance sheets of which, kindly furnished us by him, we gather that he was born in New York city, August 3, 1833, the son of parents of good scholarship and refined tastes. He began the study of his profession when eighteen years of age, with Dr. Valentine Mott, expecting to become a surgeon, but afterward turned his attention to general medicine. He began to contribute to the med-

ical press in 1857, and wrote many papers and editorial articles for several journals; and from 1867 to 1871 edited the Medical Gazette. As editor he "labored industriously to raise the standard of medical morals and of scientific essays. His reviews of literary and scientific works are so many pleas for thoroughness in research, accuracy in statement, simplicity in diction, and good taste in composition. . . . His dislike of shams and of irrational methods is exhibited throughout his essays, both medical and literary, in verse and in prose." With his other qualities he had a keen wit, which was used to good effect in his writings, and in drawings and models satirizing follies, abuses, exaggeration in fashions, and hygienic improprieties. Retiring from the editorship of the Medical Gazette in 1871, he settled for practice in New Brighton, Staten Island, till 1889, when he removed to New York city. He was a member of the Council of the New York State Medical Association, and for three years edited its transactions. His most important work was performed in sanitary science. Dr. Gouley names thirty-seven editorial articles on public health, which he published while editor of the Medical Gazette. He wrote for the World a series of articles—the Ollapod Papers—on hygiene, conveying useful information respecting the prevention of disease and the general care of the person, which were widely read. During his residence in New Brighton he gave a series of free popular lectures on hygiene. His address on the Philosophy of Health before the Alumni Association of the University Medical College of New York, and those on Public Health before the New York State Medical Association in 1885, and the American Medical Association in 1890 were of high character. In 1884 he became Secretary of the New York State Board of Health, succeeding Dr. Elisha Harris, deceased. In this position he was much consulted with reference to health laws and general sanitation. While in this office he delivered an acceptable course of lectures on hygiene at the Albany Medical College; and he gave courses on the same subject at the Mott Memorial Hall in 1890, and at the New York College of Veterinary Surgeons in 1891. Dr. Thudicum, of London, speaks of his later writings, with which only he is acquainted, as "full of original observations, keen application of the most progressive science, and conclusions of the greatest practical value."

Cheating Ancestors and Gods.—A curious industry in some of the provinces of China is the manufacture of mock money for offering to the dead. Formerly sham paper money was burned, but now mock dollars are used. They are only half the size of real dollars, but the dead are supposed not to know the difference; and, moreover, there is no more harm in cheating the dead than there is in cheating the living. To make them, tin, hammered out till it is not thicker than the thickest paper, is punched to the size of half dollars and pasted on disks of cardboard. A boy then takes the pieces, and with two dies, one representing the one side and the other the reverse, hammers impressions of dollars upon them, and the money is ready for use. Some districts of the Anhui province having been ravaged by an epidemic, so that in many places the people were not able to attend to the harvesting of the crops, an attempt was made to deceive the gods by playing at New-Year's day. Every preparation—burning fire-crackers and pasting happy sentences in red paper on the doors, and the rest—was made for celebrating the bogus New Year. The object was to make the god of sickness think he had made a mistake in the seasons, and had erred in bringing an epidemic on the people at a time when, in the course of Nature, no epidemic should appear. As any action contrary to Nature done by the gods is liable to punishment by the King of Heaven, the actors in this farce thought that the god of sickness would gather his evil spirits back to him for fear of the displeasure of his superior divinity. This child's play received the permission and co-operation of the local authorities.

The Future of Geographical Exploration.—In his recent annual address as President of the Royal Geographical Society, Mr. Clements R. Markham said that the work of geographical discovery during living memory had proceeded with such rapidity that many had been half inclined to think that there was little left to be done. There were still wide tracts, however, in all the great divisions

of the earth, which were unknown to us and which would furnish work to explorers for many years to come; while the examination of ocean depths was an important task which had but lately been begun. Moreover, there were regions of vast extent which were only very partially known to us, the more detailed examination of which would enable explorers to collect geographical information of the highest value and of the greatest interest. It was from the methodical study of limited areas that science derived the most satisfactory results. When such investigations were begun it was found how meager and inaccurate previous knowledge, derived from the cursory information picked up during some rapid march, had been. A detailed scientific monograph on a little-known region of comparatively small extent supplied work of absorbing interest to the explorer, while he had the satisfaction of knowing that his labors would be of lasting value and utility. There was sufficient work of this less ambitious but not less serviceable kind to occupy a whole army of field geographers for many decades. Exact delineation by trigonometrical measurement was their work. It was hardly begun. With the exception of countries in Europe, British India, the coast of the United States and a small part of its interior, the whole world was still unmapped.

NOTES.

Three lectures for young people were delivered in January in behalf of the Royal Geographical Society, by Douglas Freshfield, President of the Alpine Club, on Mountains. The special subjects were a brief general description of the structure and features of a mountain region; the steps by which the High Alps have gradually been discovered, conquered, and converted to human uses; and the lecturer's special field of exploration, the Caucasus.

As many as a hundred and thirty papers were read in the Meteorological Congress, in Chicago, in August, 1893. The congress was divided into nine sections: A, Prof. C. A. Schult and H. H. Clayton presiding, discussing instruments and methods of observation, especially methods of observing in the upper air; B, Prof. Cleveland Abbe, president, dealing with questions of meteorological dynamics, including thunder-storm phenomena; C, Prof. F. E. Nipher presiding, climatology; D, Major H. C. Dunwoody, president, the relation of climate to plant and animal life; E, Lieutenant W. H. Beehler, marine meteorology, ocean storms and their prediction, methods of observation at sea, and international co-operation; F, Prof. Charles Carpmel and A. Lawrence Rotch, improvement of weather service, and especially the progress of weather forecasting; G, Prof. F. H. Bigelow, problems of atmospheric electricity and terrestrial magnetism; H, Prof. Thomas Russell, rivers and the prediction of floods; I, Oliver L. Fassig, history and bibliography.

The name of the Chinook wind is taken, according to H. M. Ballou, from that of the Chinook Indians, near Puget Sound. During the prevalence of the wind the thermometer rises in a few hours from below zero to 40° or 45°. It is analogous to the Fohn of Switzerland, and similar winds are reported from various parts of the world. All that is needed to produce them are high and low pressure areas, whereby the air is caused to pass over the mountains, depositing its moisture on the ascent, and descending on the leeward side.

Strikes, it appears, are not a modern innovation, but were known centuries ago, with outcomes as disastrous as those of the present. In the year 1329 a strike of brassworkers was begun in Breslau, Silesia, which lasted a year. Fifty-six years later, in 1385, one of blacksmiths took place in Dantzic, which ended when the local authorities obtained permission to issue an edict proclaiming that until further notice any workman refusing to obey the lawful dictates of his employer as to continuing operations was to be summarily deprived of his ears.

The English National Society for the Employment of Epileptics has bought an estate in every way desirable for a proposed colony of epileptics, and is collecting means to fit it up and set the colony in operation. It will enjoy the guidance of the experience of Germany, where an epileptic colony has been in existence at Bielefeld for twenty-six years with very encouraging results, and has now more than eleven hundred epileptic inhabitants on an area of four hundred acres. The plan of the English society is to give the colony as little as possible the character of an institution. The houses will be small, as in Germany, and the inmates of each will form a separate family. The industries will be market gardening, cow-keeping, dairy work, poultry farming, and other similar occupations, besides various trades and handicrafts. The women, who will be accommodated on a separate part of the estate, will be engaged principally in laundry work, sewing, cooking, and domestic service. The children will be suitably educated and trained to various industries.

The powers of certain miraculous curative places apparently do not extend to all

diseases. W. R. Le Fanu, in his Seventy Years of Irish Life, gives the following testimony of an invalid who had sought the benefits of Knock Chapel: "Indeed, sir, I took all the rounds and said all the prayers, but it was of no use; not but what it's a grand place. It would astonish you to see all the sticks and crutches hanging up there—left behind by poor cripples who went home cured. It's my opinion, sir, that for rheumatism, and the like of that, it's a grand place entirely; but as for the liver, it's not worth a d—n."

The third session of the School of Applied Ethics will be held at Plymouth, Mass., in July and August, 1894. Lectures will be given by leading scholars in three departments, namely: those of Ethics, under the direction of Prof. Felix Adler; Economics, Prof. H. C. Adams, director; and History of Religions, Prof. C. H. Toy, director. A complete programme of the lectures is to be issued. S. Burns Weston, Secretary, 118 South Twelfth Street, Philadelphia.

OBITUARY NOTES.

Frank Bolles, Secretary of Harvard University and an esteemed contributor to The Popular Science Monthly, died at his home in Cambridge, Mass., of pneumonia, January 10th, in his thirty-eighth year. His father was the first editor of the Boston Journal, and was distinguished in public life; his mother was a sister of General John A. Dix. He was a graduate of the Columbia and the Harvard Law Schools; had considerable experience in journalistic work; contributed to literary periodicals under the signature of "Eugene Raleigh"; was a hard worker over books, and was enthusiastically fond of outdoor life and the study of Nature in all her aspects, making specialties of mountains and birds. A few years ago he bought an abandoned farm, on the edge of Chocorua Lake and at the foot of the mountain of that name, where, as he told a gentleman who called on him last summer, he spent "every minute" he could spare from his duties at Cambridge, and where he kept his pet owls and mice, etc., in summer, wintering them at Cambridge. He contributed to The Popular Science Monthly an article on Ways of the Owl, published in June, 1892, and other articles which will appear in time; published two books, describing his outdoor and mountain excursions and studies, entitled The Land of the Lingering Snow and To the North of Bear Camp Water, and was the author, besides, of some books of information concerning Harvard University, the Genealogy of the Family of Anthony Dix, Important English Statutes, and an essay on International Arbitration, which secured him the Bowdoin prize at Harvard. As Secretary of Harvard University he kept the interests of the students at heart, established an employment bureau for them, and was beloved by them.

The Rev. Samuel Lockwood, Ph. D., who died at Freehold, N. J., January 9th, aged seventy-five years, was well known by his popular articles on scientific subjects, which he invested with a rare charm of sympathetic interest. He was a close observer, particularly of animals in their various moods, and his descriptions were always picturesque, while accurate. He contributed sixteen articles to The Popular Science Monthly, beginning with the first volume. The subjects were: Crabs, Audubon's Lily, the Coatimondi, Cultivating Wild Flowers, The Enemies we Import, The Eucalyptus, Glass Sponges, The Great Cemetery in Colorado, A Mastodon, Musical Mice, The Oyster, American Owls, Scratching in the Animal Kingdom, and Sea Anemones.

Mr. Robert Bentley, of Earl's Court, an eminent English botanist, died in December, 1893. Soon after becoming a member of the College of Surgeons, in 1847, he was appointed lecturer on botany in the Medical School of the London Hospital, and Professor of Botany in King's College. His subsequent life was entirely devoted to the advancement of botanical science, and he was the author of numerous books and papers bearing upon it, and upon the application of botanical knowledge to medicine and in the arts. One of the last of his works of this kind was the editing jointly with Profs. Redwood and Attfield of the British Pharmacopœia of 1885, which is still the official standard for all medicinal preparations required by the Medical Council.

T. W. Kennard, C. E., founder of the Monmouthshire Crumlin Works, Wales, and designer and constructor of the Crumlin Viaduct, who died in September, 1893, was the engineer-in-chief of the Atlantic and Great Western Railway in the United States.

Rear-Admiral Marin H. Jansen, of the Royal Netherlands Navy, died at the Hague, September 9, 1893, on the last day of his seventy-seventh year. He was largely engaged during his active life in geographical exploration and surveying; was a correspondent of Lieutenant M. F. Maury, of the United States, in his scientific work; contributed much information in aid of his researches, and published a translation of his Physical Geography of the Sea, with valuable appendices on land and sea breezes in the tropics and on ozone, which Maury incorporated into his own subsequent editions; published an important work, in 1864, on The Latest Discoveries in Maritime Affairs; was the chief promoter of the revival of arctic exploration in Holland; and contributed other valuable services to science. He was an honorary corresponding member of the British Royal Geographical Society.

LEWIS DAVID VON SCHWEINITZ.

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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XIX.—FROM CREATION TO EVOLUTION.

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PART II.

THEOLOGICAL TEACHINGS REGARDING THE ANIMALS AND MAN.

IN one of the windows of the cathedral at Ulm a mediæval glass-stainer has represented the Almighty as engaged in creating the animals, and there has just left the divine hands an elephant fully accoutered, with armor, harness, and housings—ready for war. Similar representations appear in illuminated manuscripts and even in early printed books, and, as the culmination of the whole, the Almighty is shown as extracting, with evident effort, the first woman from the side of the first man.

This view of the general process of creation had come from far; it appeared under varying forms in various ancient cosmogonies, and, passing into our own sacred books, became the starting point of a vast new development of theology.

The fathers of the Church generally received each of the two accounts of creation in Genesis literally, and then, having done their best to reconcile them with each other and to mold them together, made them the final test of thought upon the universe and all things therein. At the beginning of the fourth century Lactantius struck the keynote of this mode of subordinating all other things in the study of creation to the literal text of Scripture, and he enforces his view of the creation of man by a bit of philology, saying the final being created "is called man because he is made from the ground—*homo ex humo*."

In the second half of the same century this view as to the literal acceptance of the sacred text was reasserted by St. Ambrose, who, in his work on the creation, declared that "Moses opened his mouth and poured forth what God had said to him." But a greater than either of them fastened this idea into the Christian theologies. St. Augustine, preparing his Commentary on the Book of Genesis, laid down in one famous sentence the law which has lasted in the Church until our own time: "Nothing is to be accepted save on the authority of Scripture, since greater is that authority than all the powers of the human mind." The vigor of the sentence in its original Latin carried it ringing down the centuries: "Major est Scripturæ auctoritas quam omnis humani ingenii capacitas."

Through the mediæval period, in spite of a revolt led by no other than St. Augustine himself, and followed by a series of influential churchmen, contending, as we shall hereafter see, for a modification of the accepted view of creation, this phrase held the minds of men firmly. The great Dominican encyclopedist, Vincent of Beauvais, in his Mirror of Nature, while mixing ideas brought from Aristotle with a theory drawn from the Bible, stood firmly by the first of the accounts given in Genesis, and assigned the special virtue of the number six as a reason why all things were created in six days; and in the later middle ages that eminent authority, Cardinal d'Ailly, accepted in a general way everything regarding creation in the sacred books as written. Only a faint dissent is seen in Gregory Reisch, another authority of this later period, who, while giving in his book on the beginning of things a full-length woodcut showing the Almighty in the act of extracting Eve from Adam's side, with all the rest of new-formed Nature in the background, leans in his writings, like St. Augustine, toward a belief in the pre-existence of matter.

At the Reformation the vast authority of Luther was thrown in favor of the literal acceptance of Scripture as the source of natural science; the allegorical and mystical interpretations of earlier theologians he utterly rejected. "Why," he asks, "should Moses use allegory when he is not speaking of allegorical creatures or of an allegorical world, but of real creatures and of a visible world, which can be seen, felt, and grasped? Moses calls things by their right names, as we ought to do. . . . I hold that the animals took their being at once upon the word of God, as did also the fishes in the sea."

Not less explicit in his adherence to the literal account of creation given in Genesis was Calvin. He warns those who, by taking another view than his own, "basely insult the Creator, to expect a judge who will annihilate them." He insists that all species of animals were created in six days, each made up of an

evening and a morning, and that no new species has ever appeared since. He dwells on the production of birds from the water as resting upon certain warrant of Scripture, but adds, "If the question is to be argued on physical grounds, we know that water is more akin to air than the earth is." As to difficulties in the scriptural account of creation, he tells us that God "wished by these to give proofs of his power which should fill us with astonishment."

The controlling minds in the Roman Catholic Church steadfastly held this view. In the seventeenth century Bossuet threw his vast authority in its favor, and in his Discourse on Universal History, which has remained the foundation not only of theological but of general historical teaching in France down to the present republic, we find him calling attention to what he regards as the culminating act of creation, and asserting that, literally, for the creation of man earth was used, and "the finger of God applied to corruptible matter."

Protestant Europe held this idea no less persistently. In the seventeenth century Dr. John Lightfoot, Vice-Chancellor of the University of Cambridge, the great rabbinical scholar of his time, attempted to reconcile the two accounts in Genesis by saying that of the "clean sort of beasts there were seven of every kind created, three couples for breeding and the odd one for Adam's sacrifice on his fall, which God foresaw"; that of unclean beasts only one couple was created; and finally, that "heaven and earth, center and circumference, were created all together, in the same instant, and clouds full of water," and that "this work took place and man was created by the Trinity on October 23, 4004 B. C., at nine o'clock in the morning." Here was, indeed, a triumph of Lactantius's method, the result of a thousand years of biblical study and theological thought since Bede, in the eighth century, and Vincent de Beauvais, in the thirteenth, had declared that creation must have taken place in the spring. Yet, alas! within two centuries after Lightfoot's great theological demonstration as to the exact hour of creation, it was discovered that at that hour an exceedingly cultivated people, enjoying all the fruits of a highly developed civilization, had long been swarming in the great cities of Egypt, and that other nations hardly less advanced had at that time reached a high development in Asia.

So literal was this whole conception of the work of creation that in these days it can scarcely be imagined. The Almighty was represented in theological literature, in the illustrations of Bibles, and in works of art generally, as a sort of enlarged and venerable Nuremberg toymaker; a pictorial representation in accordance with the well-known sacred account, showing the Creator in the act of sewing skins of beasts into coats for Adam and

Eve, presented no difficulties to the docile minds of the middle ages and Reformation period; hence it was that, when the discovery of fossils began to provoke thought, these were declared to be "models of his works approved or rejected by the great Artificer, outlines of future creations, sports of Nature," or "objects placed in the strata to bring to naught human curiosity"; and this kind of explanation lingered on until in our own time that excellent naturalist, Mr. Gosse, in his anxiety to save the literal account in Genesis, has urged that Jehovah tilted and twisted the strata, scattered the fossils through them, scratched the glacial furrows upon them, spread over them the marks of erosion by water, and set Niagara pouring all in an instant, thus mystifying the world "for some inscrutable purpose, but for his own glory." *

The next important development of theological reasoning had regard to the *divisions* of the animal kingdom.

Naturally, one of the first divisions which struck the inquiring mind was that between useful and noxious creatures, and the question therefore occurred, How could a good God create tigers and serpents, thorns and thistles? The answer was found in theological considerations upon sin: To man's first disobedience all woes were due. Great men for eighteen hundred years developed the theory that before Adam's disobedience there was no death, and therefore neither ferocity nor venom.

Some typical utterances in the evolution of this doctrine are worthy of a passing glance. St. Augustine expressly confirmed and emphasized the view that the vegetable as well as the animal kingdom was cursed on account of man's sin. Two hundred years later this utterance had been echoed on from father to father of the Church until it was caught by Bede; he declared that before man's fall animals were harmless, but became poisonous or hurtful on account of sin, and he said, "Thus fierce and poisonous animals were created for terrifying man, because God foresaw that he would sin, in order that he might be made aware of the final punishment of hell."

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* For the citation from Lactantius, see Divin. Instit., lib. ii, cap. xi, in Migne, tome vi, pp. 311, 312; for St. Augustine's great phrase, see the De Genes. ad litt., ii, 5; for St. Ambrose, see lib. i, cap. ii; for Vincent de Beauvais, see the Speculum Naturale, lib. i, cap. ii, and lib. ii, cap. xv and xxx; also Bourgeat, Études sur Vincent de Beauvais, Paris, 1856, especially chaps. vii, xii, and xvi; for Cardinal d'Ailly, see the Imago Mundi, and for Reisch, see the various editions of the Margarita Philosophica; for Luther's statements, see Luther's Schriften, ed. Walch, Halle, 1740, Commentary on Genesis, vol. i; for Calvin's view of the creation of the animals, including the immutability of species, see the Comm. in Gen., tome i of his Opera omnia, Amst., 1671, cap. i, v. xx, p. 5, also cap. ii, v. ii, p. 8, and elsewhere; for Bossuet, see his Discours sur l'Histoire universelle, Œuvres de Bossuet, tome v, Paris, 1846; for Lightfoot, see his works, edited by Pitman, London, 1822; for Bede, see the Hexæmeron, lib. i, in Migne, tome xci, p. 21.

In the twelfth century this view was incorporated by Peter Lombard into his great theological work of the Sentences, which became the text-book of theology through the middle ages. He affirmed that "no created things would have been hurtful to man had he not sinned; they became hurtful for the sake of terrifying and punishing vice or of proving and perfecting virtue; they were created harmless, and on account of sin became hurtful."

This theological theory regarding animals was brought out in the eighteenth century with great force by John Wesley. He declared that before Adam's sin "none of these attempted to devour or in any wise hurt one another"; "the spider was as harmless as the fly, and did not lie in wait for blood." Not only Wesley, but the eminent Dr. Adam Clarke and Dr. Richard Watson, whose ideas had the very greatest weight among the English Dissenters, and even among leading thinkers in the Established Church, held firmly to this theory. Not until, in our own time, geology revealed the remains of vast multitudes of carnivorous creatures, many of them with half-digested remains of other creatures in their stomachs, all extinct long ages before the appearance of man upon earth, was a victory won by science over theology in this field.

A curious development of this doctrine was seen in the belief drawn by sundry old commentators from the condemnation of the serpent in Genesis—a belief, indeed, perfectly natural, since it was evidently that of the original writers of the account preserved in the first of our sacred books. This belief was that, until the tempting serpent was cursed by the Almighty, all serpents stood erect, walked, and talked.

This belief was handed down the ages as part of "the sacred deposit of the faith" until Watson, the most prolific writer of the great evangelical reform in the eighteenth century and the standard theologian of the evangelical party, declared: "We have no reason at all to believe that the animal had a serpentine form in any mode or degree until its transformation; that he was then degraded to a reptile to go upon his belly imports, on the contrary, an entire loss and alteration of the original form." Here, again, was a ripe result of the theologic method diligently pursued by the strongest thinkers in the Church during nearly two thousand years; but this "sacred deposit" also faded away when the geologists found abundant remains of fossil serpents dating from periods long before the appearance of man.

Yet more troublesome questions arose among theologians regarding animals classed as "superfluous." St. Augustine was especially exercised thereby. He says: "I confess I am ignorant why mice and frogs were created, or flies and worms. . . . All creatures are either useful, hurtful, or superfluous to us. . . . As

for the hurtful creatures, we are either punished, or disciplined, or terrified by them, so that we may not cherish and love this life." As to the "superfluous animals," he says, "Although they are not necessary for our service, yet the whole design of the universe is thereby completed and finished." Luther, who followed St. Augustine in so many other matters, declined to follow him fully in this. To him a fly was not merely superfluous, it was noxious—sent by the devil, and perhaps possessed by the devil, to trouble him when reading.

Another subject which gave rise to much searching of the Scriptures and long trains of theological reasoning, was the difference between the creation of man and that of other living beings.

Great stress was laid by theologians from St. Basil and St. Augustine to St. Thomas Aquinas and Bossuet, and from Luther to Wesley, on the radical distinction indicated in Genesis, God having created man "in his own image"; what this statement meant was seen in the light of the later biblical statement that "Adam begat Seth in his own likeness, after his image."

In view of this and well-known texts incorporated from older creation legends into the Hebrew sacred books it came to be widely held that, while man was directly molded and fashioned separately by the Creator's hand, the animals generally were evoked in numbers from the earth and sea by the Creator's voice.

A question now arose naturally as to the *distinctions of species* among animals. The vast majority of theologians agreed in representing all animals as created "in the beginning," and named by Adam, preserved in the ark, and continued ever afterward under exactly the same species. Some difficulties arose here and there as zoölogy progressed and revealed ever-increasing numbers of species; but through the middle ages, and indeed long after the Reformation, this difficulty was easily surmounted: by making the ark of Noah larger and larger, and especially by holding that there had been a human error in regard to the unit of measurement for the ark, all difficulty was at first avoided.*

But naturally there was developed among both ecclesiastics and laymen a human desire to go beyond these special points in the history of animated beings—a desire to know what the creation really is.

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* For St. Augustine, see De Genesi and De Trinitate, *passim;* for Bede, see Hexæmeron, lib. i, in Migne, tome xci, pp. 21, 36–38, 42; and De Sex Dierum Creatione, in Migne, tome. xciii, p. 215; for Peter Lombard on "noxious animals," see his Sententiæ, lib ii, dist. xv, 3, Migne, tome cxcii, p. 682; for Wesley, Clarke, and Watson, see quotations from them and notes thereto in my chapter on Geology; for St. Augustine on "superfluous animals," see the De Genesi, lib. i, cap. xvi, 26; on Luther's view of flies, see the Table Talk and his famous utterance, "Odio muscas quia sunt imagines diaboli et hæreticorum."

Current legends, stories, and travelers' observations, poor as they were, tended powerfully to stimulate curiosity in this field.

Three centuries before the Christian era Aristotle had made the first really great attempt to satisfy this curiosity; he had begun a development of studies in natural history which remains one of the greatest achievements in the story of our race.

But the feeling which we have already seen so strong in the early Church—that all study of Nature was futile in view of the approaching end of the world, indicated so clearly in the New Testament and voiced so powerfully by Lactantius and St. Augustine—held back this current of thought for many centuries. Still, the better tendency in humanity continued to assert itself. There was indeed an influence coming from the Hebrew Scriptures themselves which wrought powerfully to this end. In spite of all that Lactantius or St. Augustine might say as to the futility of any study of Nature, the grand utterances in the Psalms regarding the beauties and wonders of creation, in all the glow of the truest poetry, ennobled the study even among those whom logic drew away from it.

But, as a matter of course, in the early Church and throughout the middle ages all such studies were cast in a theologic mold. Without some purpose of biblical illustration or spiritual edification they were considered futile; too much prying into the secrets of Nature was very generally held to be dangerous both to body and soul; only for showing forth God's glory and his purposes in the creation were such studies praiseworthy. The great work of Aristotle was under eclipse. The early Christian thinkers gave little attention to it, and that little was devoted to transforming it into something absolutely opposed to his whole spirit and method. In place of it they developed the Physiologus and the Bestiaries, in which scriptural statements, legends, and fanciful inventions were mingled with pious intent and with childlike simplicity.

In place of research came authority—the authority of the Scriptures as interpreted by the Physiologus and the Bestiaries—and these remained the principal source of thought on animated Nature for over a thousand years.

Occasionally, indeed, fear was shown among the rulers in the Church even of such poor prying into the creation as this, and in the fifth century a synod under Pope Gelasius administered a rebuke to the Physiologus; but the interest in Nature was too strong; the great work on Creation by St. Basil had drawn from the Physiologus precious illustrations of Holy Writ, and the strongest of the early popes, Gregory the Great, virtually sanctioned it.

Thus was developed a sacred science of creation and of the

divine purpose in Nature, which went on developing from the fourth century to the nineteenth—from St. Basil to St. Isidore of Seville, from Isidore to Vincent de Beauvais, and from Vincent to Archdeacon Paley and the Bridgewater Treatises.

Like all else in the middle ages this sacred science was developed purely by theological methods. Neglecting the wonders which the dissection of the commonest animals would have afforded them, these naturalists attempted to throw light into Nature by ingenious use of scriptural texts, by research among the lives of the saints, and by the plentiful application of metaphysics. Hence even such strong men as St. Isidore of Seville treasured up accounts of the unicorn and dragons mentioned in the Scriptures and of the phœnix and basilisk in profane writings. Hence such contributions to knowledge as that the basilisk kills serpents by his breath and men by his glance, that the lion when pursued effaces his tracks with the end of his tail, that the pelican nourishes her young with her own blood, that serpents lay aside their venom before drinking, that the salamander quenches fire, that the hyena can talk with shepherds, that certain birds are born of the fruit of a certain tree when it happens to fall into the water, with other masses of science equally valuable.

As to the method of bringing science to bear on Scripture, the Physiologus gives an example in illustrating the passage in the book of Job which speaks of the old lion perishing for lack of prey. Out of the attempt to explain an unusual Hebrew word in the text there came a curious development of error, until we find fully evolved an account of the ant-lion, which, it gives us to understand, was the lion mentioned by Job, and it says: "As to the ant-lion, his father hath the shape of a lion, his mother that of an ant; the father liveth upon flesh and the mother upon herbs; these bring forth the ant-lion, a compound of both and in part like to either; for his fore part is like that of a lion and his hind part like that of an ant. Being thus composed, he is neither able to eat flesh like his father nor herbs like his mother, and so he perisheth."

The same sort of science flourished in the Bestiaries, which were used everywhere and especially in the pulpits for the edification of the faithful. In all of these, as in that compiled early in the thirteenth century by an ecclesiastic, William of Normandy, we have this lesson, borrowed from the Physiologus: "The lioness giveth birth to cubs which remain three days without life. Then cometh the lion, breatheth upon them, and bringeth them to life. . . . Thus it is that Jesus Christ during three days was deprived of life, but God the Father raised him gloriously."

Pious use was constantly made of this science, especially by

monkish preachers. The phœnix rising from his ashes proves the doctrine of the resurrection; the structure and mischief of monkeys prove the existence of demons; the fact that certain monkeys have no tails proves that Satan has been shorn of his glory; the weasel, which "constantly changes its place, is a type of the man estranged from the word of God, who findeth no rest."

The moral treatises of the time often took the form of works on natural history, in order the more fully to exploit these religious teachings of Nature. Thus from the Dominican Thomas of Cantimpré, who called his book De Apibus (On Bees), we learn that "the wasps persecute the bees and make war on them out of natural hatred"; and these, he tells us, typify the demons who dwell in the air and with lightning and tempest assail and vex mankind—whereupon he fills a long chapter with anecdotes of such demonic warfare on mortals. In like manner his fellow-Dominican, the inquisitor Nider, in his book the Ant Hill, teaches us that the ants in Ethiopia, which are said to have horns and to grow so large as to look like dogs, are emblems of atrocious heretics, like Wyclif and the Hussites, who bark and bite against the truth; while the ants of India, which dig up gold out of the sand with their feet and hoard it, though they make no use of it, symbolize the fruitless toil with which the heretics dig out the gold of Holy Scripture and hoard it in their books to no purpose.

This pious spirit not only pervaded science, it bloomed out in art, and it meets us especially in the cathedrals. In the gargoyles overhanging the walls, in the grotesques clambering about the towers or perched upon pinnacles, in the dragons prowling under archways or lurking in bosses of foliage, in the apocalyptic beasts carved upon the stalls of the choir, stained into the windows, wrought into the tapestries, illuminated in the letters and borders of psalters and missals, these marvels of creation suggested everywhere morals from the Physiologus, the Bestiaries, and the Exempla.*

* For the Physiologus, Bestiaries, etc., see Berger de Xivrey, Traditions Tératologiques; also Hippeau's edition of the Bestiary of Guillaume de Normandie, Caen, 1852, and such mediæval books of Exempla as the Lumen Naturæ; also Hoefer, Histoire de la Zoologie; also Rambaud, Histoire de la Civilisation Française, Paris, 1885, vol. i, pp. 368, 369; also Cardinal Pitra, preface to the Spicilegium Solismense, Paris, 1855, *passim*; also Carus, Geschichte der Zoologie; and for an admirable summary, the article Physiologus in the Encyc. Brit. In the illuminated manuscripts in the Library of Cornell University are some very striking examples of grotesques. For admirably illustrated articles on the Bestiaries, see Cahier and Martin, Mélanges d'Archéologie, Paris, 1851, 1852, and 1856, vol. ii of the first series, pp. 85–232, and second series, volume on Curiosités Mystérieuses, pp. 106–164; also J. R. Allen, Early Christian Symbolism in Great Britain and Ireland (London, 1887),

Here and there among men who were free from church control we have work of a better sort. In the twelfth and thirteenth centuries Abd Allatif made observations upon the natural history of Egypt which showed a truly scientific spirit, and the Emperor Frederick II attempted to promote a more fruitful study of Nature; but one of these men was abhorred as a Mussulman and the other as an infidel. Far more in accordance with the spirit of the time was the ecclesiastic Giraldus Cambrensis, whose book on the topography of Ireland bestows much attention upon the animals of the island, and rarely fails to make each contribute an appropriate moral. For example, he says that in Ireland "eagles live for so many ages that they seem to contend with eternity itself; so also, the saints, having put off the old man and put on the new, obtain the blessed fruit of everlasting life." Again, he tells us, "Eagles often fly so high that their wings are scorched by the sun; so those who in the Holy Scriptures strive to unravel the deep and hidden secrets of the heavenly mysteries, beyond what is allowed, fall below as if the wings of the presumptuous imaginations on which they are borne were scorched."

In one of the great men of the following century began to appear a slight gleam of healthful criticism: Albert the Great, in his work on the animals, dissents from the widespread belief that certain birds spring from trees and are nourished by the sap, and also from the theory that some are also generated in the sea from decaying wood.

But it required many generations for such skepticism to produce much effect, since we find among the illustrations in the edition of Mandeville published about the time of the Reformation not only careful accounts but a pictured representation of birds produced in the fruit of trees.*

This general employment of natural science for biblical illustration and the edification of the faithful went on after the Reformation. Luther frequently made this use of it, and his example controlled his followers. In 1612 Wolfgang Franz, Professor of Theology at Luther's university, gave to the world his sacred history of animals, which went through many editions. It contained a very ingenious classification, describing "natural drag-

lecture vi; for an exhaustive discussion of the subject, see, Das Thierbuch des wormannischen Dichters Guillaume le Clerc, herausgegeben von Reinisch, Leipsic, 1890; and, for an Italian example, Goldstaub und Wendriner, Ein Tosco-Venezianischer Bestiarius, Halle, 1892, where is given, on pp. 369–371, a very pious but very comical tradition regarding the beaver, hardly more than mentionable to ears polite.

* For Giraldus Cambrensis, see the edition in the Bohn Library, London, 1863, p. 30; for Abd Allatif and Frederick II, see Hoefer, as above; for Albertus Magnus, see the De Animalibus, lib. xxiii; for the illustrations in Mandeville, see the Strasburg edition, 1484.

ons," which have three rows of teeth to each jaw, and he piously adds, " the principal dragon is the Devil."

Near the end of the same century, Father Kircher, the great Jesuit professor at Rome, holds back the skeptical current, insists upon the orthodox view, and represents among the animals entering the ark sirens and griffins.

Yet even among theologians we note here and there a skeptical spirit in natural science. Early in the same seventeenth century Eugène Roger published his Travels in Palestine. As regards the utterances of Scripture he was soundly orthodox; he prefaces his work with a map showing, among other important points referred to in biblical history, the place where Samson slew a thousand Philistines with the jawbone of an ass, the cavern which Adam and Eve inhabited after their expulsion from paradise, the spot where Balaam's ass spoke, the place where Jacob wrestled with the angel, the steep place down which the swine possessed of devils plunged into the sea, the position of the salt statue which was once Lot's wife, the place at sea where Jonah was swallowed by the whale, and "the exact spot where St. Peter caught one hundred and fifty-three fishes."

As to natural history, he sees, describes, and discusses with great theological acuteness the basilisk. He tells us that the animal is about a foot and a half long, is shaped like a crocodile, and kills people with a single glance. The one which he saw was dead, fortunately for him, since in the time of Pope Leo IV—as he tells us—one appeared in Rome and killed many people by merely looking at them; but the Pope destroyed it with his prayers and the sign of the cross. He informs us that Providence has wisely and mercifully protected man by requiring the monster to cry aloud two or three times whenever it leaves its den, and that the divine wisdom in creation is also shown by the fact that the monster is obliged to look its victim in the eye and at a certain fixed distance before its glance can penetrate the victim's brain and so pass to his heart. He also gives a reason for supposing that the same divine mercy has provided that the crowing of a cock will kill the basilisk.

Yet even in this good and credulous missionary we see the influence of Bacon and the dawn of experimental science; for, having been told many stories regarding the salamanders, he secured one, placed it alive upon the burning coals, and reports to us that the legends concerning its power to live in the fire are untrue. He also tried experiments with the chameleon, and found that the stories told of it were to be received with much allowance: while, then, he locks up his judgment whenever he discusses the letter of Scripture, he uses his mind in other things much after the modern method.

In the second half of the same century Hottinger, in his Theological Examination of the History of Creation, breaks from the belief in the phœnix; but his skepticism is carefully kept within the limits imposed by Scripture. He avows his doubts, first, "because God created the animals in couples, while the phœnix is represented as a single, unmated creature"; secondly, "because Noah, when he entered the ark, brought the animals in by sevens, while there were never so many individuals of the phœnix species"; thirdly, because "no man is known who dares assert that he has ever seen this bird"; fourthly, because "those who assert there is a phœnix differ among themselves."

In view of these attacks on the salamander and the phœnix, we are not surprised to find before the end of the century an attack on the basilisk; the eminent Prof. Kirchmaier, at the University of Wittemberg, treats both phœnix and basilisk alike as old wives' fables. As to the phœnix, he denies its existence, not only because Noah took no such bird into the ark, but also because "birds come from eggs, not from ashes." But the unicorn he can not resign, nor will he even concede that the unicorn is a rhinoceros; he appeals to Job and to Marco Polo to prove that this animal, as usually conceived, really exists, and says, "Who would not fear to deny the existence of the unicorn, since Holy Scripture names him with distinct praises?" As to the other great animals mentioned in Scripture, he is so rationalistic as to admit that behemoth was an elephant and leviathan a whale.

But these germs of a fruitful skepticism grew, and we soon find Dannhauer going a step further and declaring his disbelief even in the unicorn, insisting that it was a rhinoceros, only that and nothing more. Still, the main current continued strongly theological. In 1712 Samuel Bochart published his great work upon the animals of Holy Scripture. As showing its spirit we may take the titles of the chapters on the horse:

Chapter VI. Of the Hebrew name of the horse.

Chapter VII. Of the colors of the six horses in Zechariah.

Chapter VIII. Of the horses in Job.

Chapter IX. Of Solomon's horses and of the texts wherein the writers praise the excellence of horses.

Chapter X. Of the consecrated horses of the sun.

Among the other titles of chapters are such as: Of Balaam's Ass; Of the Thousand Philistines slain by Samson with the Jawbone of an Ass; Of the Golden Calves of Aaron and Jeroboam; Of the Bleating, Milk, Wool, External and Internal Parts of Sheep mentioned in Scripture; Of Notable Things told regarding Lions in Scripture; Of Noah's Dove and of the Dove which appeared at Christ's Baptism. Mixed up in the book with the principal mass

drawn from Scripture were many facts and reasonings taken from investigations by naturalists; but all were carefully permeated by the theological spirit.*

The inquiry into Nature having thus been pursued nearly two thousand years theologically, we find by the middle of the sixteenth century some promising beginnings of a different method—the method of inquiry into Nature scientifically—the method which seeks not plausibilities but facts. At that time Edward Wotton led the way in England and Conrad Gesner on the continent, by observations widely extended, carefully noted, and thoughtfully classified.

This better method of interrogating Nature soon led to the formation of societies for the same purpose. In 1560 was founded an Academy for the study of Nature at Naples, but theologians, becoming alarmed, suppressed it, and for nearly one hundred years there was no new combined effort of that sort until in 1645 began the meetings in London of what was afterward the Royal Society. Then came the Academy of Sciences in France, and the Academia del Cimento in Italy; others followed in all parts of the world, and a great new movement was begun.

Theologians soon saw a danger in this movement. In Italy, Prince Leopold dei Medici, a protector of the Florentine Academy, was bribed with a cardinal's hat to neglect it, and from the days of Urban VIII to Pius IX a similar spirit was there shown. In France there were frequent ecclesiastical interferences, of which Buffon's humiliation for stating a simple scientific truth was a noted example. In England Protestantism was at first hardly more favorable toward the Royal Society, and the great Dr. South denounced it in his sermons as irreligious.

Fortunately, one thing prevented an open breach between theology and science; while new investigators had mainly given up the mediæval method so dear to the Church, they had very generally retained the conception of direct creation and of design throughout creation—a design having as its main purpose the profit, enjoyment, instruction, and amusement of man.

On this the naturally opposing tendencies of theology and science were compromised. Science, while somewhat freed from its old limitations, became the handmaid of theology in illustrating the doctrine of creative design, and always with apparent

* For Franz and Kircher, see Perrier, La Philosophie Zoologique avant Darwin, Paris, 1884, p. 29; for Roger, see his La Terre Saincte, Paris, 1664, pp. 89–92, 139, 218, etc.; for Hottinger, see his Historiæ Creationis Examen theologico-philologicum, Heidelberg, 1659, lib. vi, Quæst. lxxxiii; for Kirchmaier, see his Disputationes Zoologicæ (published collectively after his death), Jena, 1736; for Dannhauer, see his Disputationes Theologicæ, Leipsic, 1707, p 14; for Bochart, see his Hierozoikon, sive De Animalibus Sacræ Scripturæ, Leyden, 1712.

deference to the Chaldean and other ancient myths and legends embodied in the Hebrew sacred books.

About the middle of the seventeenth century came a great conquest of the scientific over the theologic method. At that time Francesco Redi published the results of his inquiries into the doctrine of spontaneous generation. For over two hundred years the accepted doctrine had been that water, filth, and carrion had received power from the Creator to generate worms, insects, and a multitude of the smaller animals. This doctrine had been especially welcomed by St. Augustine and many of the fathers, since it relieved the Almighty of making, Adam of naming, and Noah of living in the ark with these innumerable despised species. But to this fallacy Redi put an end. By researches which could not be gainsaid, he showed that every one of these animals came from an egg; each, therefore, must be the lineal descendant of an animal created, named, and preserved from "the beginning."

Similar work went on in England, but with a more distinctly religious tendency. In the same seventeenth century a very famous and popular English book was that by the naturalist John Ray, a fellow of the Royal Society, who produced a number of works on plants, fishes, and birds; but the most widely read among all his books was entitled The Wisdom of God manifested in the Works of Creation. Between the years 1691 and 1827 it passed through nearly twenty editions.

Ray argues the goodness and wisdom of God from the adaptation of the animals not only to man's uses but to their own lives and surroundings.

In the first years of the eighteenth century Dr. Nehemiah Grew, of the Royal Society, published his Cosmologia Sacra to refute anti-scriptural opinions by producing evidences of creative design. Discoursing on "the ends of Providence," he says, "A crane, which is scurvy meat, lays but two eggs in the year, but a pheasant and partridge, both excellent meat, lay and hatch fifteen or twenty." He points to the fact that "those of value which lay few at a time sit the oftener, as the woodcock and the dove." He breaks decidedly from the doctrine that noxious things in Nature are caused by sin, and shows that they, too, are useful; that, "if nettles sting, it is to secure an excellent medicine for children and cattle"; that, "if the bramble hurts man, it makes all the better hedge"; and that, "if it chances to prick the owner, it tears the thief." "Weasels, kites, and other hurtful animals induce us to watchfulness; thistles and moles, to good husbandry; lice oblige us to cleanliness in our bodies, spiders in our houses, and the moth in our clothes." This very optimistic view, triumphing over the theological theory of noxious animals and plants as effects of sin, which prevailed with so much force from St. Augustine to

Wesley, was developed into nobler form during the century by various thinkers, and especially by Archdeacon Paley, whose Natural Theology exercised a powerful influence down to recent times. The same tendency appeared in other countries. Various philosophers did indeed show weak points in the argument, and Goethe made sport of it in a noted verse, praising the forethought of the Creator in foreordaining the cork tree to furnish stoppers for wine-bottles.

Shortly before the middle of the nineteenth century the main movement culminated in the Bridgewater Treatises. Pursuant to the will of the eighth Earl of Bridgewater, the President of the Royal Society selected eight persons, each to receive a thousand pounds sterling for writing and publishing a treatise on the "power, wisdom, and goodness of God, as manifested in the creation." Of these, the leading essays in regard to animated Nature were those of Thomas Chalmers, on The Adaptation of External Nature to the Moral and Intellectual Condition of Man; of Sir Charles Bell, on The Hand, as evincing Design; of Roget, Animal and Vegetable Physiology with reference to Natural Theology; and of Kirby, on The Habits and Instincts of Animals with reference to Natural Theology.

Besides these there were treatises by Whewell, Buckland, Kidd, and Prout. The work was nobly done. It was a marked advance on all that had appeared before in matter, method, and spirit. Looking back upon it now we can see that it was provisional, but that it was none the less fruitful in truth. Here we may well remember Darwin's remark on the stimulating effect of mistaken theories, as compared with the sterilizing effect of mistaken observations: mistaken observations lead men astray, mistaken theories suggest true theories.

An effort made in so noble a spirit certainly does not deserve the ridicule that, in our own day, has sometimes been lavished upon it. Curiously, indeed, one of the most contemptuous of these criticisms has been recently made by one of the most strenuous defenders of orthodoxy. No less eminent a standard-bearer of the faith than the Rev. Prof. Zoeckler says of this great movement to demonstrate creative purpose and design, and of the men who took part in it, "The earth appeared in their representation of it like a great clothing shop and soup kitchen, and God as a glorified rationalistic professor." Such a statement as this is far from just to the conceptions of such men as Butler, Paley, and Chalmers, no matter how fully the thinking world has now outlived them.*

* For Ray, see the work cited, London, 1827, p. 153. For Grew, see Cosmologia Sacra, or a Discourse on the Universe, as it is the Creature and Kingdom of God; chiefly written

But, noble as the work of these men was, the foundation of fact on which they reared it became evidently more and more insecure.

As far back as the seventeenth century far-sighted theologians had begun to discern difficulties more serious than any that had before confronted them. More and more it was seen that the number of different species was far greater than the world had hitherto imagined. Greater and greater had become the old difficulty in conceiving that, of these innumerable species, each had been specially created by the Almighty hand, that each had been brought before Adam by the Almighty to be named, and that each, in couples or in sevens, had been gathered by Noah into the ark. But the difficulties thus suggested were as nothing compared to those raised by the *distribution* of animals.

Even in the first days of the Church this had aroused serious thought, and above all in the great mind of St. Augustine. In his City of God he had stated the difficulty as follows: "But there is a question about all these kinds of beasts, which are neither tamed by man, nor spring from the earth like frogs, such as wolves and others of that sort, . . . as to how they could find their way to the islands after that flood which destroyed every living thing not preserved in the ark. . . . Some, indeed, might be thought to reach islands by swimming, in case these were very near; but some islands are so remote from continental lands that it does not seem possible that any creature could reach them by swimming. It is not an incredible thing, either, that some animals may have been captured by men and taken with them to those lands which they intended to inhabit, in order that they might have the pleasure of hunting, and it can not be denied that the transfer may have been accomplished through the agency of angels, commanded or allowed to perform this labor by God."

But this question had now assumed a magnitude of which St. Augustine never dreamed. Most powerful of all agencies to increase this difficulty were the voyages of Columbus, Vasco da Gama, Magellan, Amerigo Vespucci, and other great navigators of the period of discovery. Still more serious became the difficulty as the continent islands of the southern seas were explored. Every navigator brought home tidings of new species of animals and of races of men living in parts of the world where

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to demonstrate the Truth and Excellency of the Bible, by Dr. Nehemiah Grew, Fellow of the College of Physicians and of the Royal Society, London, 1701. For Paley and the Bridgewater Treatises, see the usual editions; also Lange, History of Rationalism. Goethe's couplet ran as follows:

"Welche Verehrung verdient der Weltenerschöpfer, der Gnädig,
Als er den Korkbaum ersehuf, gleich auch die Stopfel erfand."

For the quotation from Zoeckler, see his work already cited, vol. ii, pp. 74, 440.

the theologians, relying on the explicit statement of St. Paul that the gospel had gone into all lands, had for ages declared there could be none; until finally it overtaxed even the theological imagination to conceive of angels, in obedience to the divine command, distributing over the earth the various animals, dropping the megatherium in South America, the archeopteryx in Europe, the ornithorhynchus in Australia, and the opossum in North America.

It was under the impression made by the beginnings of this new array of facts established by the earlier voyages of discovery that in 1667 Abraham Milius published at Geneva his book on The Origin of Animals and the Migrations of Peoples. An acute author says that this book shows, as no other does, the shock and strain to which the discovery of America subjected the received theological scheme of things. The book was issued with the full and special approbation of the Bishop of Salzburg, and it indicates the possibility that a solution of the whole trouble might be found in the text, "Let the earth bring forth the living creature after his kind." Milius goes on to show that the ancient philosophers agree with Moses, and that "the earth and the waters, and especially the heat of the sun and of the genial sky, together with that slimy and putrid quality which seems to be inherent in the soil, may furnish the origin for fishes, terrestrial animals, and birds." On the other hand, he is very severe against those who imagine that man can have had the same origin with animals. But the subject with which Milius especially grapples is the distribution of animals. He is greatly exercised by the many species found in America and in remote islands of the ocean—species entirely unknown in the other continents—and of course he is especially troubled by the fact that these species existing in those exceedingly remote parts of the earth do not exist in the neighborhood of Mount Ararat. He confesses that to explain the distribution of animals is the most difficult part of the problem. If it be urged that birds could reach America by flying and fishes by swimming, he asks, "What of the beasts which neither fly nor swim?" Yet even as to the birds he asks, "Is there not an infinite variety of winged creatures who fly so slowly and heavily, and have such a horror of the water, that they would not even dare trust themselves to fly over a wide river?" As to fishes, he says, "They are very averse to wandering from their native waters," and he shows that there are now reported many species of American and East Indian fishes entirely unknown on the other continents, whose presence, therefore, can not be explained by any theory of natural dispersion.

Of those who suggest that land animals may have been dispersed over the earth by the direct agency of man for his use or

pleasure he asks: "Who would like to get different sorts of lions, bears, tigers, and other ferocious and noxious creatures on board ship? who would trust himself with them? and who would wish to plant colonies of such creatures in new, desirable lands?"

His conclusion is that plants and animals take their origin in the lands wherein they are found—an opinion which he brings Moses to support with passages from the two narrations in Genesis which imply generative force in earth and water.

But in the eighteenth century matters had become even worse for the theological view. To meet the difficulty the eminent Benedictine, Dom Calmet, in his commentary expressed the belief that all the species of a genus had originally formed one species, and he dwelt on this view as one which enabled him to explain the possibility of gathering all animals into the ark. This idea, dangerous as it was to the fabric of orthodoxy and involving a profound separation from the general doctrine of the Church, seems to have been abroad among thinking men, for we find in the latter half of the same century even Linnæus incline to consider it. It was, indeed, time that some new theological theory be evolved; the great Linnæus himself, in spite of his famous declaration in favor of the fixity of species, had dealt a death blow to the old theory. In his Systema Naturæ, published in the middle of the eighteenth century, he had enumerated four thousand species of animals, and the difficulties involved in the naming of each of them by Adam and in bringing them together in the ark appeared to all thinking men more and more insurmountable.

What was more embarrassing, the number of distinct species went on increasing rapidly, indeed enormously, until—as an eminent zoölogical authority of our own time has declared, "For every one of the species enumerated by Linnæus, more than fifty kinds are known to the naturalist of to-day, and the number of species still unknown doubtless far exceeds the list of those recorded."

Already there were premonitions of the strain made upon Scripture by requiring a hundred and sixty distinct miraculous interventions of the Creator to produce the hundred and sixty species of land shells found in the little island of Madeira alone, and fourteen hundred distinct interventions to produce the actual number of distinct species of a single well-known shell.

Ever more and more difficult, too, became this question of the geographical distribution of animals. As new explorations were made in various parts of the world, this danger to the theological view went on increasing. The sloths in South America suggested painful questions: how could animals so sluggish have got away from the neighborhood of Mount Ararat so completely and have traveled so far?

The explorations in Australia and neighboring islands made matters still worse, for there was found in those regions a whole realm of animals differing widely from those of other parts of the earth.

The problem before the strict theologians became, for example, how to explain the fact that the kangaroo can have been in the ark and be now only found in Australia; his saltatory powers are indeed great, but how could he by any series of leaps have sprung across the intervening mountains, plains, and oceans to that remote continent; and, if the theory were adopted that at some period a causeway extended across the vast chasm separating Australia from the nearest mainland, why did not lions, tigers, camels, and camelopards force or find their way across it?

The theological theory, therefore, had by the end of the last century gone to pieces. The wiser theologians waited; the unwise indulged in exhortations to "root out the wicked heart of unbelief," in denunciation of "science falsely so called," and in frantic declarations that "the Bible is true"—by which they meant that the limited understanding of it which they had happened to inherit is true.

By the middle of the nineteenth century the whole theological theory of creation—though still preached everywhere as a matter of form—was clearly seen by all thinking men to be hopelessly lost; such strong men as Cardinal Wiseman in the Roman Church, Dean Buckland in the Anglican, and Hugh Miller in the Scottish Church, made heroic efforts to save something from it, but all to no purpose. That sturdy Teutonic and Anglo-Saxon honesty, which is the best legacy of the middle ages to Christendom, asserted itself in the old strongholds of theological thought—the universities. Neither the powerful logic of Bishop Butler nor the nimble reasoning of Archdeacon Paley availed. Just as the line of astronomical thinkers from Copernicus to Newton had destroyed the old astronomy, in which the earth was the center, and the Almighty sitting above the firmament the agent in moving the heavenly bodies about it with his own hands, so now a race of biological thinkers had destroyed the old idea of a Creator minutely contriving and fashioning all animals to suit the needs and purposes of man. They had developed a system of a very different sort, and of this we shall speak in the next chapter.*

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* For Abraham Milius, see his De Origine Animalium et Migratione Populorum, Geneva, 1667; also Kosmos, 1877, H. 1, S. 36; for Linnæus's declaration regarding species, see the Phil. Bot., 99, 157; for Calmet and Linnæus, see Zoeckler, vol. ii, p. 237. As to the enormously increasing numbers of species in zoölogy and botany, see President D. S. Jordan, Science Sketches, pp. 176, 177; also, for pithy statement, Laing's Problems of the Future, chap. vi.

TRUSTS THEIR OWN CORRECTIVE.

By GEORGE A. RICH.

THE test of a theory is to predict what will happen. When the cry was first raised a few years ago against the so-called trusts, and legislation of one kind and another was proposed, there were those who declared that if these combinations were left alone they would prove their own worst enemies. In other words, there were inherent weaknesses in the trust mode of doing business which, so far as the public was concerned, took all the teeth out of it. But the politicians and legislators brushed this contention aside as so much "rubbish" and "mere theory," and proceeded to attempt by statutory enactment what an early pope had tried by bull—that is, to stay the operation of a natural law. As to how well they succeeded, the failure of the Government to enforce the anti-trust law, and the rapid increase of these combinations in the face of popular opposition, constitute a sufficient answer. In the meantime the prediction, which they so curtly rejected, is receiving its verification in the developments now taking place among those great organizations of capital and industry.

The most effective of these corrective agencies are the unequal conditions brought about by the union of weak establishments with strong ones and the certainty of competition. The original object of the combination was to prevent disastrous competition. To be sure, the apparent success of some of the chief ones has dazzled the minds of business men and led to the formation of others for the sole purpose of realizing larger profits at the expense of the public. But an examination of the history of most of them will show that they grew out of bitter contests which threatened disaster and ruin to those engaged in the industry. This movement toward consolidation dates in this country from the close of the civil war. The return of capital to the normal channels of industry following that led to an overstimulation in many branches. Up to that time the productive capacity of the country had not been equal to its capacity of consumption. With manufacturers it had been a race for possession. But that point had been passed. Possible production was in excess of possible consumption, and it became with many a question of divide or fight. From the point of the manufacturers the preliminary combinations which followed were open to two serious objections: They could not be established by contract, because the common law treated such agreements as against public policy, while the statute law made it a misdemeanor to enter into them. Furthermore, where the law was evaded and such agreements

were entered into, they proved in nearly every case inoperative, from the fact that there was no power to enforce their conditions. The consolidation of competing interests or the principle of "division," therefore, seemed the only thing possible. This was notably the position of the Michigan salt manufacturers, whose association was the outgrowth of competition so fierce that many of them went to the wall. It is likewise true of the whisky trust. When the United States Government, near the beginning of the civil war, raised the internal revenue tax on whisky by successive stages from twenty cents to two dollars per gallon, with a considerable interval intervening between the several advances, an extraordinary stimulus was given to the manufacture. Distilleries without number sprang into existence. The result was that the output was far beyond the necessities of the market and it was a ruinous fight for life. In less degree this was the case with the cordage, cotton-oil, and bagging trusts.

Now, it is evident that combinations so formed stand in an anomalous position. Made up of both strong and weak establishments, the resulting corporation may be more powerful than some of its constituent members, but it is far from being equal to its prosperous ones. It is loaded down with old factories and antiquated machinery; it is capitalized at three or four times its actual value; and its managers are obliged, if they do what is expected of them, to support this rubbish and pay a profit besides. Were these combinations protected in the full control of their market, and were their products such that the public could not do without them or find a substitute for them, they might count on something like success. But capital is always on the outlook for prizes. It is always ready to make daring ventures in the hope of large returns. The fact that any one of these combinations can make eight or ten per cent on an inflated capital is clear evidence that the return for legitimate investment might be much greater. So the independent operator enters the field. The inevitable war of prices has been delayed a little, but the delay has permitted the growth of new and powerful organizations against the old concerns.

This point has been admirably illustrated in the experiences of the lead trust. It was not long ago that the annual meeting of the stockholders of that enterprise was held, and in the report of the president appeared this significant statement: "There has been, and always will be, competition in each class of goods manufactured by this company. It does not aim to obtain monopoly." The facts are, however, that at the beginning of 1892 the trust had control of all the lead-works in this country with the exception of two small establishments, one in Boston and one in Philadelphia; and even these were bound to it by ironclad

contracts. It was as full a control of an industry as could be had. Of course, large profits were possible; but capital was attracted to the field. As a result, new plants were started until there are at the present time works enough outside the trust to equal its output. But there is this striking difference between the trust and the independent manufacturers: the plants of the trust are capitalized for thirty million dollars; the independent plants, equal in capacity, represent an investment of only two million dollars.

The course of the linseed-oil trust has been analogous. In 1887, when the trust was started, it controlled between sixty and seventy per cent of the output of that product. As such it had the manipulation of the market and realized handsome profits, despite the fact that it had to face the independent crushers and was hampered by watered capital. But, to do it, it raised the price of linseed oil so high that the attention of others was drawn to the industry. The president of the trust in his report for 1891 said: "It is not considered by your board of directors advisable to publish a detailed statement of the affairs of the company, for the reason that we find by the experience of the past year that our statements find their way into the public press. If made in detail, information is given to our competitors, to the detriment of this company. There is no doubt whatever that the publicity given to our last annual statement caused the building of new works and consequent increase in competition." These independent crushers, strengthened by the newcomers and unhampered by weak plants, were able to wrest the market from the trust. Some months ago the trust sought a conference with its rivals and an effort was made to come to an understanding. That, however, has proved a failure, and competition ruled in the linseed-oil market.

Furthermore, it is impossible to get control of any article in general demand. Such an attempt may temporarily succeed, but there are powerful forces which will drag it down sooner or later. As an English writer says: "It is difficult to conceive of any body of capitalists being sufficiently powerful to monopolize an article in general demand and to use their monopoly for any length of time to the serious hurt of the public. Directly prices became prohibitive there would be a formidable movement in the opposite direction and the monopoly would break down."

The fate of the copper syndicate is a striking proof of this. This scheme consisted in nothing less than forestalling the market of the whole world in copper for the period of three years. This the managers attempted to accomplish, and did accomplish for a time, by buying the output of all the copper mines in the world for that period by agreeing to pay the mine owners thir-

teen cents per pound and one half of whatever the syndicate should be able to get above that. The immediate effect of this gigantic conspiracy was that the price of copper in the United States rose from thirteen to sixteen cents per pound. But the syndicate did not take the precaution to buy up all the old scrap copper in the world, nor all the metals that could be substituted in the arts for copper. Nor did it arrange with those who had been consuming copper that they should use it in the same quantities whatever the price. The result was that the syndicate collapsed, dragging down with it one of the great banking institutions of France, ruining an untold number of individuals, and driving to suicide the man who conceived the undertaking.

The same points of weakness are apparent in the other combinations now before the public. Despite the tremendous power of the sugar trust, it has never been able to control the market for any length of time, as an examination of the prices of sugar for the years of its existence will show. The independent refiners have forced it to reduce its quotations, and later buy their plants up at a high valuation if it wished to escape competition. No sooner has that been done, however, than new refineries have been started, as is the situation at the present time. Obviously there must be an end to this procedure, even for a corporation with such resources as the American Sugar Refining Company has. The same is true of the cordage trust. So strong an opponent of trusts as the New York Commercial Bulletin said of this at the time it was at the height of apparent prosperity: "The enormous profits which the trust is now making can not but lead to the establishment of additional independent plants. These will be in as strong a position for successful competition as has been found to be the case with the independent refiners of sugar. Under these circumstances the present enormous profits made by the cordage trust will not continue." The later fate of this same cordage company is a sad but striking commentary on the weaknesses to which such enterprises are open.

It is not contended that these corrective agencies will of themselves work the downfall of the trusts. That is an impossibility under the present industrial conditions. But they will fix a limit beyond which the trust can not go. Furthermore, they will hasten the overthrow of all those combinations which seek to carry along old and worthless plants and to follow discarded processes of manufacture and wasteful methods of business. The trust mode of doing business as a means of getting large capital and realizing the economies consequent on extensive production may be a success; but as a means of practicing extortion upon the public it is doomed to failure. Natural laws, after all, are stronger than the contrivances of man.

NEW LIGHTS ON THE PROBLEM OF FLYING.

By Prof. JOSEPH LE CONTE.

SOME of the readers of The Popular Science Monthly may remember that in November, 1888, I published an article in which I tried to show the physical impossibility of a true flying machine—i. e., one which could both lift and propel itself without the help of a balloon. The article was widely commented upon, the only objection urged being the threadbare one that more wonderful things than this have come to pass and will come to pass again. Since that time, however, a very elaborate series of experiments by Prof. Langley has thrown so much and so new light on the whole problem of flying, that I am forced to reconsider and modify somewhat the conclusions then reached. Having been asked to contribute a paper on the subject of flying to the World's Congress of Aëronautics, I, a few months ago, reviewed the whole subject in the light of these new experiments. The pressure of other duties at that time prevented me from putting my thoughts in final form, and I laid aside my notes. But I feel that I owe it to myself, as well as to The Popular Science Monthly, that I should again express my views under the changed conditions. This article, therefore, may be regarded as substantially what I would have given at the World's Congress if I had had time then to prepare it.

But this time I find it necessary to take up the subject from a more general point of view than before. My theme now is the problem of flying, both natural and artificial. I begin, therefore, with some discussion of the flight of birds.

The bird's wing has two distinct functions, viz., that of a propeller and that of an aëroplane. Both of these functions are performed by the wing in ordinary flight, but in different relative proportions according to the size of the bird and the extent of its wings. In insects and in small birds the wings act almost wholly as propellers. In large birds with great expanse of wings, except in rising, they act mainly as an aëroplane. This difference between small and large birds is fully recognized in my previous paper, but I did not then appreciate its supreme importance. Now it is on the properties of an aëroplane that the new light has been mainly shed, and it is therefore of its function in flight that I shall have most to say. First, however, a very few words on the bird's wing as a propeller.

The structure of a bird's wing is a marvel of exquisite contrivance—a wonderful combination of lightness, elasticity, and strength. The hollow quill, the tapering shaft, the vane composed of barbs clinging together by elastic hooks, making thus an

impermeable yet flexible plane—all this has been often insisted on by writers on design in Nature. But there are two points not so often noticed which especially concern us here.

1. Of the two vanes of each feather, the hinder one is much the broader. This, together with the manner of overlap, causes

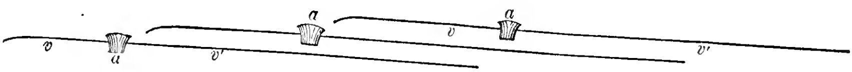

Fig. 1.—Longitudinal Section of the Wing Plane and Cross-section of Three Feathers. *a*, shaft; *v*, *v'*, vane.

the feathers to rotate and close up into an impervious plane in the downstroke, and to open and allow the air to pass freely through in the upstroke, as shown in the figure (Fig. 1). This structure and arrangement produce the greatest possible effectiveness of the downstroke and the least possible loss in recovery for another stroke.

2. The plane of the wing is supported not along the middle, but along the extreme anterior border, as shown in Fig. 2, which

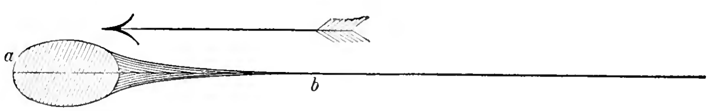

Fig. 2.—Diagrammatic Cross-section of Bird's Wing. *a*, wing bones; *b*, plane.

is a diagrammatic cross-section of the wing. The effect of the down stroke is to tip up the wing behind, as shown in Fig. 3. The whole force of the stroke, *a b*, is resolved into two components—one, *a c*, sustaining, and the other, *b c*, propelling onward. In easy flight, therefore, only downward flapping is necessary, al-

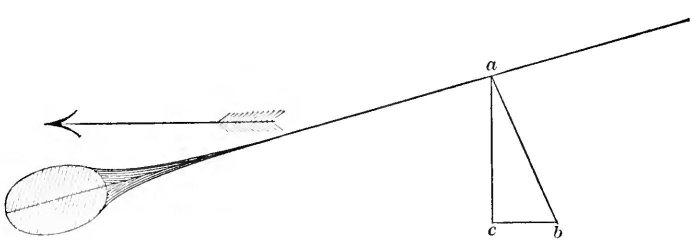

Fig. 3.—Diagrammatic Cross-section of Bird's Wing during Downstroke. *a*, *b*, whole force; *a*, *c*, part sustaining; *b*, *c*, part propelling.

though in rapid flight doubtless the stroke is also a little backward.

The same admirable adaptation is carried out in every part of the bird. The whole bird is an exquisitely constructed flying machine. The smallness of the head, the feet, and the viscera,

the lightness and the strength of the bones, all show that everything is subordinated to this one supreme function. In comparing a bird with an artificial flying machine it is necessary to bear this in mind.

But it is in the use of the wing as an aëroplane that the most wonderful feats of bird locomotion consist. If we are ever to achieve artificial flight it must be by the application of the principles underlying these. There are four of these feats of bird flight which require special notice as bearing on the subject of artificial flight. These are *hovering*, *poising*, *soaring*, and *sailing*.

Hovering.—There is some confusion in the use of this term. It always refers to a maintenance of a body in one position in the air; but this may be done in two ways—either by vigorous flapping of the wings, or else, under certain conditions, with no motion of the wings at all. This latter, however, I shall call poising, and confine the term hovering to the former. In this sense hovering is seen in many insects and in the humming bird, and, among larger birds, in the sparrow hawk (*Falco sparverius*) and in the osprey (*Pandion haliætus*). In these it is seen that in hovering the body is inclined upward, and the stroke of the wing is decidedly forward as well as downward. The reason of this is, as already explained, that downward strokes give onward motion. But the main thing to be observed in large birds is the violent struggles necessary to maintain position compared with the ease of onward flight. This difference furnishes the key to the properties of an aëroplane, and was, I believe, first explained by Marey. In maintaining the body in the same position, as in hovering, the air gives way under each stroke of the wing, creating a downward current, thus greatly diminishing the effectiveness of the downstroke and increasing the loss in recovery or upstroke. In progressive flight, on the contrary, and more and more as the progress is more rapid, every phase of the downstroke is on new air. The wing strikes on three feet or six feet or ten feet or twenty feet of air, according to the velocity of progress, with every stroke. The air has not time to give way before the wing passes on to new, unmoved air. But if it is difficult to maintain one position, as in hovering, it is evidently still more difficult, on this principle, to raise the body directly upward. This explains the difficulty experienced by a large bird like the condor in rising, and yet the ease and grace of progressive flight when well up. We will see hereafter the great importance of this principle, as shown by the experiments of Langley.

Poising.—By this term I mean the maintenance of a fixed position with outstretched, motionless wings. During my boyhood I was fond of field sports of all kinds, and therefore a constant and accurate observer of the flight of birds; and yet, dur-

ing all that time, I never saw this feat. The reason was, that I lived in a perfectly flat country. I saw it for the first time when, at the age of fifteen, in going to college, I moved to a rolling country. It is best seen in a *bare* rolling country, like much of the western portion of the United States. The most perfect poising I have ever seen done was by the red-tailed hawk (*Buteo montanus*), on the bare, rolling lava plains of eastern Oregon. The conditions absolutely necessary are a rolling country and a steady breeze. The bird places himself above the brow of a hill with face to the wind. As long as the wind remains steady the bird retains his position, with outstretched wing, motionless.

The explanation is as follows: As already said, the bird places himself facing the wind just above the brow of a hill. The wind is deflected upward by the slope of the hill. The bird places his aëroplane (wings and tail) in a plane inclining slightly downward, but not so much inclined as the slope of the hill, so that the wind still strikes the under side of the aëroplane. In this position the force of gravity would carry him downward and forward, while the wind would carry him upward and backward. The bird skillfully adjusts the position of the aëroplane so that these two opposite forces shall exactly balance one another. As long as the wind remains steady his position is unchanged. If the wind changes in direction or in velocity, he wiggles himself a little, perhaps flaps once or twice, until he finds a new position of equilibrium, and again remains steady. This explanation is, I believe, complete.

Soaring.—It is well known that many large and long winged birds, such as vultures, hawks, pelicans, etc., will sweep about in wide circles with motionless, outstretched wings, not only maintaining their level, but rising in ascending spiral until they disappear from view. I have often watched their easy, graceful motion for hours, and am quite sure that it is accomplished without any expenditure of energy at all commensurate with the work of elevation. How is it done ? There is no problem of bird-flight upon which so much has been written, and so little of any value. Let us see first what are the necessary conditions.

1. Every careful observer must have noted that the bird slopes downward along one half of the circle, so as to acquire high velocity, and then rises along the other half to a higher level than that from which he descended. How can he rise higher ?

2. Every clear thinker must see that this feat is impossible, and every careful observer must have noted that it is never done —in still air. For if air is still, even if there were no friction and no tendency to fall toward the ground, the most that the velocity acquired by the down slope could do would be to carry the bird back to the same level again. Therefore, in still air the bird must

descend instead of ascend. A necessary condition, therefore, is wind; and, indeed, a soaring bird always drifts with the wind. The spiral is never upright, but always inclined to leeward. In soaring, the bird slopes downward with the wind, then turns and rises, facing the wind. How does wind help him?

3. The feat is physically impossible in an even current of air. It is strange that this is not seen at once; and yet excellent writers have become confused on this point. I confess that until recently I have been confused myself. It really follows as a necessary consequence of the last conditions—for an even current is still air to the bird immersed in it, precisely as the earth is practically still to us dwelling on it. If a cloud should intervene between the bird and the earth, it would be impossible for him to know whether he was in a current or not.

4. Therefore, in order to rise in a spiral without doing work by flapping, there must be differential currents, which the bird takes advantage of to do the work.

Explanation.—Now, there are such differential air currents. Wind, like all other currents, increases in velocity from bottom upward. Experiments show that on a grass meadow the velocity eight feet above ground is double of that at one foot, and the velocity goes on increasing upward. A gentle breeze on the plain becomes a furious wind on the mountain-top. Like all other currents, too, there are differential currents side by side, the velocity along some stream lines being greater than along others. Also in air currents, especially, the velocity varies in time—i. e., the wind blows in puffs. These differential currents, both side by side and in altitude in time, would be evident at once if we could see the air. Now, the bird feels these invisible differential currents, and skillfully uses them to lift himself. In soaring, the bird slopes downward with the wind, acquiring thus great velocity, passes into a lower current of less velocity, then turns facing the wind, and shoots up a slope which carries him higher than the level of the start, then turns again in a current of still higher velocity, then descends again along a slope and repeats the same cycle.

To explain more definitely: Observe (1) that the lines of a bird are so fine that the front resistance is almost zero. There is practically only skin friction, which is also small. Observe (2) that with large aëroplane and rapid motion the fall by gravity is also very small. This is proved by experiments of Langley, to be described presently. Therefore, if the differential force of the air currents through which he circles is precisely equal to the skin friction plus the downward tendency, the bird will just rise to the level of the starting point; if greater, he will rise above that level. In order to rise, therefore, the differential force of the successive

currents must be greater than this small amount. As the bird is immersed in the current, and if he uses the whole available differential force in rising, none is left over for progress against the wind. He therefore drifts with the wind.

I have spoken thus far only of differential currents in altitude, for these can always be depended upon, but there may be also differential currents side by side. These might be utilized in the same way. The same may be said also of differential currents in time—i. e., successive puffs or gusts. The bird may take advantage of these. If so, he would slope down with the gust and come back and rise in the interval.

5. Sailing.—Many large birds fly with alternate intervals of flapping and sailing. But in such cases the bird always loses either velocity or height during the sail, which it recovers only by flapping. There is nothing remarkable in this. But some sea birds which live almost continuously on the wing and usually in a high wind, acquire an almost incredible expertness in the use of the wings as an aëroplane, and sometimes go for hours and over many miles of space without flapping once. The most wonderful bird in this regard is probably the albatross. On several voyages from Oregon to San Francisco I have watched these birds with their long, narrow wings rigidly extended, skimming the surface of the sea, then rising and wheeling and swooping, and again skimming, but without moving a feather for hours. I will briefly describe the phenomenon as I have seen it. The explanation will be brought out as I proceed.

I will suppose a wind aft, as was the case in most of my observations. The bird follows the boat, skimming the very surface of the sea perhaps for several hours; then, finding that he is losing ground, wheels about, facing the wind, shoots up to forty or fifty feet above the sea, then turns again with the wind, swoops down a steep incline, acquiring great speed both by the high velocity of the upper stratum and by the descent, then skims the surface again, and quickly overtakes the boat, to repeat the same evolution. With head wind these evolutions are more frequent. As before, he skims the surface behind the boat, but more quickly begins to lose ground; then rises and then wheels and swoops downward, leaving the boat; then, having acquired the necessary velocity, he again turns and skims the surface in air of small velocity, and in spite of head wind overtakes the boat, to repeat the same evolution. For hours these evolutions are repeated, the wings remaining motionless, with only varying position toward the wind.

Here, again, the bird takes advantage of the great difference of velocity between the lower and the upper strata of the air. Doubtless, also, with head wind, advantage is taken of eddies in the wake

of the boat. In all cases, if the wind slackens, the bird flaps now and then. If it stops, he flaps all the time. It can not be done in still air.

With the wind on the side the evolution must of course be different, but, as I have not watched this case, I will describe it as given by a writer in Nature (Nature, vol. xliii, p. 223, 1891).

Fig. 4 represents the stern of the boat and the circle of the bird's path. The arrows show the directions of the motion of the boat, of the wind, and of the bird. In the circle the strong line represents the higher portion of the circular sweeps and the light line the lower portion, almost in contact with the water's surface. It is seen, then, that the bird swoops down with the wind, skims the surface, and then rises against the wind. The sweep of the bird is here represented as a circle, because the boat is standing still; but really it is an advancing spiral, following the moving boat. The explanation here is exactly the same as in soaring, except that the differential force of the air currents is utilized in progress instead of in rising.

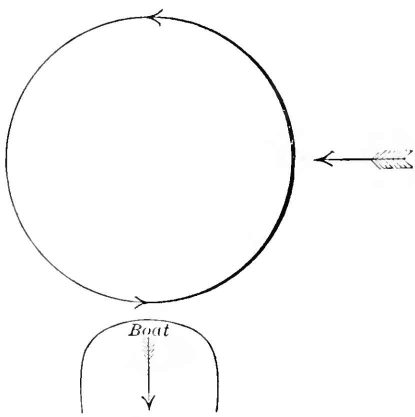

Fig. 4.—Arrows show Direction of Wind, of the Boat, and of the Circling Bird.

One more example: On the ferry boat going across the bay to San Francisco, with strong wind ahead and a little to the right (i. e., coming through the Golden Gate), I have several times seen a gull place himself behind on the left, just opposite the hind deck, and maintain his position with motionless wings for a half mile or more—I say motionless with confidence, because he was so near that I could see his eyes wink.

In this case I feel sure that the motion of the boat created an eddy in which the air was still or perhaps moving in contrary direction—i. e., with the boat, and perhaps also a little upward. If the air currents had been visible, I have no doubt the explanation would have been obvious. What I could not see, the bird felt and skillfully utilized.

Now, if birds, even the largest and heaviest of them, can thus play and gambol in the fiercest wind with the greatest ease and grace, and without serious expenditure of energy, but only by the skillful use of wings as an aëroplane, why can not we by artificial means—i. e., by a machine—do the same? The article before referred to was written to show why we can not.

The outline of the argument, the reader will remember, was as follows:

1. There is a limit to the size and weight of any locomotive machine, whether natural or artificial. This limit is the result of the law that while the strength of material and force of all kinds, whether by muscular contraction or by steam pressure, increase as the square of the diameter of muscle or of piston, the weight of the machine varies as the cube of the diameter of all parts. Thus with increasing size, weight must quickly overtake and pass beyond strength. This limit varies with the kind of machine. The limit of an efficient walking machine was probably reached in the largest land animals of previous geological times. For a rolling machine like a locomotive engine or a bicycle, where the weight is supported on wheels, or in a swimming machine where the weight is supported by water, and where, therefore, in both cases the whole energy is expended in progression, the limit is much higher; and, therefore, a locomotive engine and a whale may be heavier than any walking animal.

2. The limit of weight of a flying machine is very much lower than that of either a swimming, rolling, or a walking machine. The limit of an efficient, manageable flying machine is in fact reached in the largest birds, such as in the condor among long-winged and the bustard among short-winged birds, and to our surprise we find it only about fifty pounds. The condor can barely lift himself from the ground, although when well up he sails with ease and grace. There are, indeed, still larger birds, like the ostrich, but they can not fly. True, their wings are rudimentary, but they have become so only because these birds have passed beyond the flying limit.

3. Now, a bird is admirably constructed for economy of force. Not only is everything sacrificed to the one supreme object of flying, but the animal machine, using fats and starch for fuel and getting energy through the mechanism of nerve and muscle, is admittedly more economical and efficient—i. e., will develop more force and do more work for the same weight of fuel and machine—than any artificial machine yet devised. It seems hopeless to surpass it. Therefore, the weight of a machine that will be able to lift itself in the air can not exceed fifty or a hundred pounds.

4. But it is idle to talk of a flying machine with fuel and engineer and freight being less than many times this limit. Therefore, a flying machine which is anything more than a toy is impossible.

Such is a bare outline of the argument which seemed then—and to a large extent seems now—irrefutable. But Langley's recent experiments certainly put the question in a new and somewhat more hopeful light; and renewed reflection on the whole

subject, in the light of these experiments, has led me to some important modifications of my previous views. What, then, if any, are the fallacies in the above argument? *

1. We have spoken of two functions in the wing, viz., as propeller and aëroplane. These two are of necessity united in the bird. The bird's wing was not made at once—a special organ for a special purpose—but by modification of limbs. But there was only one pair of limbs to spare for the purpose of flying, and therefore one organ, the wing, was used for both functions. Now, there is probably a disadvantage in this; for short wings with great rapidity and sweep of the stroke are probably the best propellers, while long wings are undoubtedly the best aëroplanes. Thus in long-winged birds, like the condor, the ability to rise quickly and fly rapidly is sacrificed to easy, graceful, long-continued circling and sailing; while short-winged birds, like the turkey and bustard, rise more easily and fly more rapidly, but never remain long on the wing. There seems little doubt that the limit of weight in rising is higher in short-winged birds; and the great flightless birds were of this kind before they passed beyond the limit of flight and their wings became rudimentary. Now, it is needless to say that in artificial flying these two functions may and will be separated. The propeller will be used wholly for lifting and onward progress. I suppose, therefore, that the limit of weight may be raised higher than I have placed it. But if this were all, I can not think that it could be pushed much, if at all, beyond one hundred pounds. But this is not all.

2. We have said that the animal body using fats and starch as fuel, and getting force through the mechanism of nerve and muscle, is more economical—i. e., will generate more force and do more work with the same weight of fuel and machine—than any artificial contrivance yet devised or likely to be devised. This is certainly true; but there is another important element here concerned, viz., the *intensity* of the force—i. e., the amount of force developed and *work done in a given time*. This depends on the *rate* of combustion of the fuel. Now, there is a strict limit to the rate of combustion of fuel, and therefore of development of force, in the animal body. This limit may doubtless be greatly overpassed in an artificial machine. But be it remembered that this entails greater weight of fuel and of all parts of the machine en-

* Among these possible fallacies or oversight of my previous article I have not thought it worth while to mention the difference between the reciprocating motion of a wing and the steady pressure of a screw propeller such as would probably be used in any artificial machine; because I believe that, in the comparison, what is lost in the bird's wing in recovery for another stroke, is gained in the application of the force in the direction of greates efficiency.

gaged in the generation and transmission of force. What we want more specially is (1) a material stronger in proportion to weight than bone. This, no doubt, we have in steel tubes.* Here, then, is a positive gain. But (2) we also want a force more intense than muscular contraction, which is, I believe, about a hundred to a hundred and twenty pounds per square inch of cross-section. This can doubtless be surpassed, but not without increased weight of containing and transmitting parts. If anything can be gained in this direction (which is doubtful), against it must be set over the greater economy of the natural machine. The problem is an exceedingly complex one, and can be solved only by careful experiments. But let us admit that, by greater strength of material and greater intensity of force, the limit of weight of machine and fuel which can be lifted in the air may be pushed to several hundred pounds. This, I am sure, is as far as we can go on this score.

3. But the most important new light is found in the effect of motion on the sustaining power of an aëroplane, and the greatest flaw in my previous reasoning is the imperfect recognition of this principle.

As already stated, this principle was first brought out by Marey, and was alluded to in my previous paper, but its supreme importance was not fully appreciated until the experiments of Langley. In his hands it becomes almost a new principle, and one which must modify not only our theory of flying, but even our theory of projectiles. Langley's experiments bring out the unexpected result that in air a body does not fall the same distance in a given time whether it falls straight downward from rest or is affected with horizontal motion—that its motion in the latter case is not a resultant of distance of downward fall from rest and horizontal motion. The same is true of all bodies, but the difference is greatly exaggerated in the case of aëroplanes. According to his experiments, a thin aëroplane of material two thousand times the specific gravity of air, say aluminum, in perfectly horizontal position and free to fall, would take four times as much time to fall a certain distance if moving horizontally twenty feet per second as it would if falling directly downward from rest. With still greater velocities the time of falling a given distance is greater and greater, until it may become almost inappreciable. The reason is plain. The aëroplane falling straight downward must press the air out of its way. It takes time to do this. Now, if it is moving horizontally edge on, before the air can move appreciably, the plane is already on to new still air. Or, to put it more definitely, supposing the aëroplane to be one foot square,

* It is probably a mistake to suppose that aluminium or any alloy of that metal is stronger, weight for weight, than steel.

then, if falling straight downward, one square foot section of air must be moved in a given time; but if moving onward twenty feet per second, then twenty square feet must be started in motion in the given time. Thus with increasing velocity the air becomes more and more rigid because more and more must be started in motion in given time, until, if velocity is infinite, the air becomes immovably rigid.*

We have spoken thus far of a perfectly horizontal plane moving edge on, and therefore with no front resistance. But if the plane be slightly inclined upward in the direction of motion, then the onward motion would tend to sustain the plane. The whole air pressure may be resolved into two parts, one resisting onward progress and one sustaining the plane; and when this latter is equal to the weight the plane will not fall at all. Now, as velocity increases, less and less inclination is necessary to get the requisite sustaining force. But with less inclination comes also less front resistance. Thus at very high velocity the aëroplane may be placed nearly horizontal with proportionally small front resistance and yet sufficient sustaining power. Thus it follows from this important principle that instead of force increasing as the square of the velocity attained (or even higher rate), as in a steamboat, the increase of force with increasing velocity is unexpectedly moderate. This, of course, applies only to the aëroplane. Resistance to the attached machine follows the usual law. But this is small in comparison with the sustaining power of the æroplane. Therefore, once get a flying machine, even one of great weight, with its aëroplane well up in the air and moving onward, and there seems to be no physical impossibility of sustaining it indefinitely and giving it by means of suitable propellers a great velocity, say of forty to sixty miles per hour.

In the light of this new principle (for such it may be called) Langley and Maxim have constructed models of flying machines, and expect eventually to solve the problem of flying. A small model of a machine which he calls an aërodrone (air-runner) has been constructed by Langley, and was to have been exhibited at

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* A striking illustration of this principle is seen in the extreme rigidity of the jet issuing from the nozzle of a hydraulic pipe. The water is under a pressure of three hundred or four hundred feet head, and is projected with a velocity which would cut in two a man's body. If the jet is struck with a crowbar, the bar rebounds as it would from steel. In penetrating, say, half an inch, the bar encounters an immense quantity of water at once.

It is evident also that the same principle must apply to all bodies moving in the air, and therefore also to projectiles. There is, then, a kind of truth in the popular notion that velocity holds up or prevents the fall of a rifle ball—not, indeed, that the velocity itself holds up the ball, as popularly supposed (for it would not do so in a vacuum), but that the air is more effective in sustaining a moving body than one falling directly downward from rest.

Chicago at the World's Congress of Aëronautics. This model was fifteen feet long, with two transverse aëroplanes forty feet from tip to tip. Whether it was so exhibited or not I do not know. Maxim, it is said, is now constructing a flying machine on a large scale in London, but has not attempted yet to launch it. In both of these the aëroplane slightly inclined is the main reliance for sustaining when once in motion; so that the whole power of the engine and propellers is concentrated on rising and progress through the air.

Now, in the light of these experiments, what may we reasonably expect in the near future?

There are many difficulties in the way of success, which, of course, these men clearly see and will try to provide for. These are mainly three, viz.: (1) Difficulty of rising; (2) stability in progress; and (3) safety in alighting. We take these in succession.

1. Rising.—Every word I have said in my previous paper, only modified as to limit of weight, applies here still and without abatement. It seems to be impossible for any machine, natural or artificial, of greater weight than at most a few hundred pounds, to lift itself *straight up* in the air, or even to maintain itself in the same place like a hovering bird, by the force of propellers alone and without the aid of a balloon. Therefore, there must be some device other than, or in addition to, propellers to raise the machine in the act of starting. But observe, I said straight up. Many birds can not rise so. They must rise at very gentle incline. They must get onward motion before their wings can get full effect on the air. It is said that the mode of taking the condor is to build a pen, say, forty to fifty feet in diameter and six feet high, and put a carcass in the middle of it. The condor alights, but can not again rise at an angle which will take him over the fence. Many heavy-bodied, short-winged ducks rise from the water at so small an angle that they must use both feet and wings for thirty to forty feet in order to get onward motion enough to give effectiveness to their wings by coming in contact with larger masses of still air, as already explained. It follows, therefore, that the flying machine must have some station device to start it. It may be an elevator, but more probably it will be machine rollers on a railway. With aëroplane spread and slightly inclined and propellers directed a little backward, velocity might be got sufficient to sustain and finally with the help of the propellers to raise the machine. As far as I can learn, this is the plan of Maxim.

Viewed in the light of the new principle, there is certainly nothing impossible in this. But every machine is liable to accidents. It is absolutely necessary that we should be able to stop and go on again. Suppose in mid-flight anything should go

wrong and it is necessary to alight, how is the machine to rise again without the station device? A locomotive machine that can not stop anywhere and again resume its journey is an impracticable one. This, I think, will prove the greatest of all the difficulties.

2. Stability in Progress.—Once fairly up, as already seen, there is no reason why a moving aëroplane should not sustain a heavy flying machine indefinitely if nothing disturbs its equilibrium. Therefore, once up, we might hope for success in still air, or even possibly in a perfectly uniform current. But air currents are extremely variable in time (puffs and gusts) and in space—i. e., air streams of varying velocities and varying directions. When we see the frantic evolutions of a badly made kite, or of any kite if the steadying string breaks, we are warned of the danger of our aëroplane at high speed and with variable wind, unless skillfully managed, perhaps by means of several independent propellers and adjustable aëroplanes. In the bird we have the last perfection of skill acquired by constant practice and inherited through successive generations. Even if the science of aviation were perfect, the exquisite art necessary to manage such a machine seems almost hopelessly unattainable.

3. Safety in Alighting.—If the last—i. e., stability in progress—be attained, I suppose this also may be. In still air, by checking the velocity by the use of the propellers, the aëroplane would let down the machine with all the gentleness desirable. With head wind, also, there is no reason why alighting should not be successful. With the wind aft, it would be necessary to turn about and face the wind, as a bird does under similar circumstances. A parachute, with tubular opening atop, descends with perfect steadiness.*

4. To all these difficulties we must add the enormous hazard of a first attempt, the apparent impossibility of approaching success gradually, and thus practicing the difficult art of managing with safety.

Conclusion.—Under present lights, therefore, it is no longer justifiable to say, as I have previously done, that a flying machine is physically impossible. I therefore retract that expression. But the engineering difficulties are enormous and possibly insurmountable. At the present time the nearest approach to success in aërial locomotion is still to be found in the French dirigible balloon—i. e., a balloon propelled and steered by machinery—and for some time to come the best success may still be looked for in that direc-

* The Chinese have most ingeniously utilized this principle in the construction of little kites shaped like a bird, with wings and tail. These require no long, steadying tail, because the wings are made tubular at the tips, and the outrush of the air keeps the kite steady.

tion. In fact, the art of managing a true flying machine is so refined and the skill required so great, and in the absence of such skill the danger of a first attempt is so extreme, that probably the only way to achieve true flight would be by the use first of a dirigible balloon, and then gradually to decrease the sustaining gas and substitute the aëroplane and propeller.

In the distant future, and by means of such gradual approaches, the engineering difficulties in the way of a true flying machine may be finally overcome. If so, then we may look for the greatest success in the direction of the work of Langley and Maxim.

Addendum, January 23, 1894.

The above article was finished and sent to the publisher some time in October, 1893. In the January number of the American Journal of Science Prof. Langley published an account of another epoch-making series of experiments bearing on this subject. In his previous series he showed the enormous importance of onward movement in the sustaining power of an aëroplane. In this he shows the enormous variation of velocity in air currents from moment to moment. The whole air is in a violent turmoil from varying currents. In the above article I have shown that soaring and sailing are impossible without differential air currents; but the amount of difference of velocity of these currents shown by Prof. Langley was wholly unexpected. These experiments, therefore, show that the supply of force from this source available to the bird or to the flying machine is far greater than previously supposed. While they do not seriously vitiate any of my conclusions, they certainly place the subject of artificial flight in a still more hopeful light.

Mr. Bruce, of the Dundee antarctic whaling fleet, describes the whole of the district south of 60° south latitude as strewn with icebergs, which become very numerous south of 62°. On one day the author counted at one time from deck sixty-five of great size, besides many smaller ones. The highest berg seen from his vessel, the Balaena, was about two hundred and fifty feet high; but many were not more than seventy or eighty feet, the average possibly being about one hundred and fifty feet high. All these bergs are tabular, or weather-worn varieties of the tabular forms. They become pierced with caves, and these are sometimes connected with funnel holes, through which, as the swell beats up the caves, immense columns of spray are projected. They may be finely castellated, pillared, or arched. One was beautifully conical. The base of the bergs was colored pale brown by marine organisms, and other brown streaks were seen beyond the water-level. No luminous glow was observed. "Clothed in mist, they raise their mighty snow-clad shoulders to a stately height, or shine forth brilliantly in the sun. Although they are of the purest white, yet they glow with color. The crevices exhibit rich cobaltic blue, and everywhere are splashes of emerald green."

THE METHOD OF HOMING PIGEONS.

By C. F. HODGE, Ph.D.,
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WHEN Sir John Lubbock * rotated a paper disk upon which ants were moving in a given direction and the ants turned so as to maintain their course, it seemed as if they were endowed with some mysterious sense or power of direction, like that of a magnetic needle upon its pivot. When he substituted for the plain disk a circular hat-box, which, as he thought, must constitute for an ant the entire visible universe, and still the ants turned as the box was rotated, the fact seemed proved. Ants must have located within their bodies, and independent of ordinary sensory impressions from the external world, the power of going in any direction they wish. This conclusion is far reaching in its consequences. If ants possess such mysterious power, may it not exist in other, or all, animals? It must be of the nature of a special sense. Where, then, is the sense organ? How should ideas of animal sensation be modified by it?

Many writers would have ceased experimenting at this point, and gone off into chapters of ecstatic hypothesis about this fathomless mystery, this unmistakable "sense of direction" developed to such perfection in so humble a creature. Not so with Lubbock. When he covered the hat-box, then rotated it, the ants did not turn, but were turned with the box; or when he shifted the position of his candles to the opposite side, as he rotated the box, the ants did not turn. And so their action fell from the realm of exquisite mystery to take its place among such commonplaces as that of the sailor steering his course by the lighthouse or the stars, or that of a man guided home by the light of his own camp fire.

A considerable literature, *pro* and *con*, has gathered about the subject, in which we find frequent use of such expressions as "direction-sense," "*sens de la direction*," "sense of orientation," "*faculté d'orientation*," "instinct of location," "magnetic sense," "*Orientierungssinne*," "*Gefühl der Kardinalrichtungen*," and many more. By whatever terms designated, the idea is that animals possess some special sense, some occult faculty, by which, without reference to external objects, they are able to guide their movements aright. This power, it is commonly thought, is not possessed, or only in a rudimentary degree, by civilized man, is more highly developed in savages, and may be found in its perfection in certain migratory animals.

* Sir John Lubbock. Ants, Bees, and Wasps. New York, 1882. See pp. 260 ff.

The literature* is open to the general criticism that the strange and exceptional is noted, while by far the more important, common, and usual occurrence rarely appears in print; and thus queer stories of dogs and cats, horses, mules, birds, insects, and even men,† who are able to point unerringly north, no matter how blindfolded or manipulated, come to predominate. Still, as the methods of animals have come to be studied with scientific

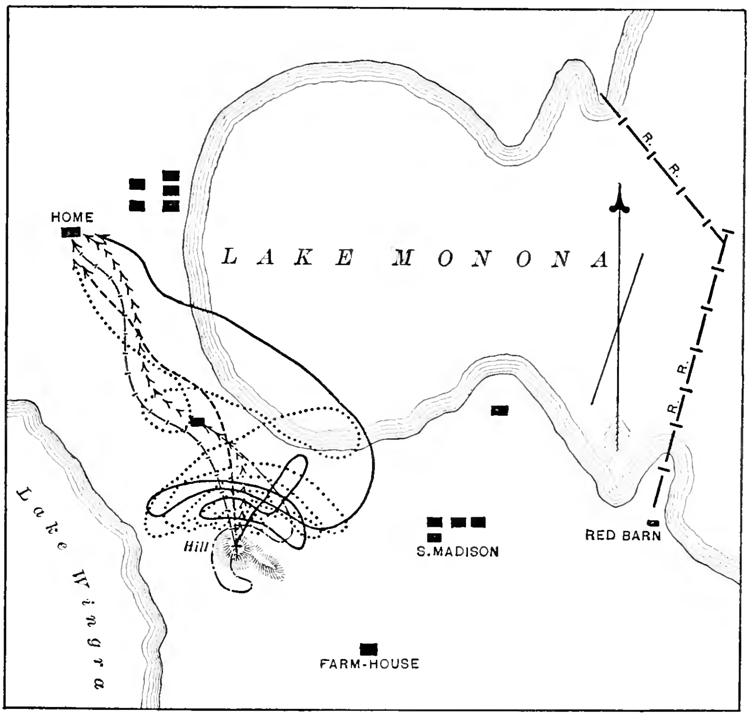

Fig. 1.

Flight of six pigeons, open cage.

accuracy, these notions have been compelled to flit from one form to another in most lively fashion.

Migratory birds, most careful study has proved, learn their route from "zone to zone," and follow it solely by means of vision. "This," Mr. Wallace says, "is now well ascertained." The work of Sir John Lubbock, of Forel, and the perfectly conclusive experiments of Mr. and Mrs. Peckham,‡ leave no resting place for

* For a running discussion of the subject, refer to Science, vol. xx, pp. 207, 248, 291, 318, 358.

† Rudski. Ueber ein angeborenes Gefühl der Kardinalrichtung des Horizonts. Biologisches Centralblatt, vol. xi, p. 63.

‡ Proceedings of the Natural History Society of Wisconsin, 1887, pp. 113 ff.

the idea among insects; and developments in anthropology teach that savages depend solely for directions upon a skillful use of the external signs of Nature.

All this may be true. It still remains an utter impossibility that a homing pigeon can return from a distance of over a thousand miles if unaided by some special "sense of direction." Such a view is rarely held by a practical pigeon fancier. He knows too well how many birds he loses, even with most careful short-distance training. He has observed that his birds, until they have learned the country, generally consume time enough to enable them to hunt over mile by mile a vast area, and that they can do nothing in a fog or snowstorm, or if blindfolded or hooded. Twenty years ago Leonard * wrote as follows: "Some writers, chiefly poets and romancers, would have us believe that the carrier pigeon finds his way home from remote places by a kind of instinct; but this is not the case. Its flight is guided by sight alone. When let loose from confinement, it rises to a great height in the air by a series of constantly enlarging circles until it catches sight of some *familiar landmark* by which to direct its course."

Had "poets and romancers" continued sole occupants of the field, the following notes would have served no other than the private purpose for which they were taken. † As it is, a number of attempts have recently been made by men of high scientific attainments to prove theories of "direction-sense" by feats of the homing pigeon. In general, such attempts are made in line with one or the other of two assumptions. According to the one, "direction-sense" is ascribed to some mysterious, direct, and immediate perception or sensation of location or direction in space. More often it is supposed to be a sort of "dead reckoning" which the organism has become able to keep—that is, the animal has come to have a feeling, definite or vague, as to how long, how fast, and which way it has traveled or has been carried. Two papers may be cited as giving possibly the best expositions of these two views. The one by Prof. Exner ‡ adduces evidence to prove the "dead-reckoning" theory; the other, by Prof. Caustier,# attempts to establish that of immediate perception. Both agree as to the organ—viz., the membranous labyrinth, especially the semicircular canals.

There is nothing impossible about Exner's explanation. All

* E. B. Leonard. Pigeon Voyagers. Harper's Monthly, vol. xlvi, p. 659, 1873.

† My own experiments related to a study of extreme fatigue of the nervous system, and for this purpose homing pigeons were furnished me by the generosity of Dr. S. Weir Mitchell. It thus became necessary, in order to credit accurately the amount of effort put forth in any given instance, to observe their habits and methods of flight.

‡ S. Exner. Das Räthsel der Brieftauben. Wien, 1892.

E. Caustier. Les Pigeons Voyageurs. Revue de l'Hypnotisme, July, 1892, p. 10.

animals, by the processes going on in their bodies, must have some notion of time. This would give the "how long" element in the problem. The "how fast" might be given by such an in-

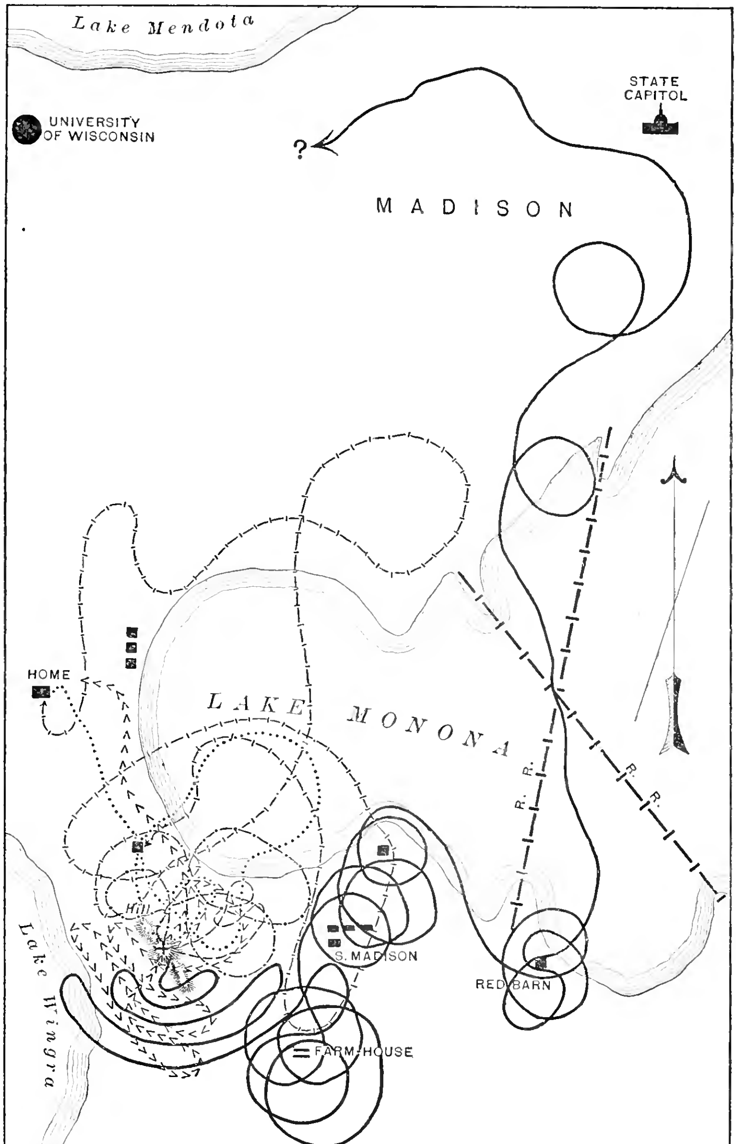

Fig. 2.

Flight of six pigeons, covered cage.

strument as we find in the otoliths resting on the sensory hairs of the *maculæ acousticæ,* these hairs bending under the weight more or less, according to rate of movement. The "which way" could

easily be indicated by a bending of the sensory hairs of the *cristæ acousticæ* as the liquid in the semicircular canals is thrown this way or that by angular deviation of line of motion. Experimental test of the theory is impossible, since, after injury of a single semicircular canal, the birds refuse to fly at all. It must rest, therefore, upon facts obtained from observation of habits and methods employed by homing pigeons. If it is true, there should appear some relation between the flight of a bird home and the course by which it has been carried to the place of liberation. It should either tend to retrace its course or to follow a straight line home. However, the writer has not been able to record a single fact which points in this direction.

Graver objections must be admitted to obtain against the theory of M. Caustier, tinted as it is by the "electro-magnetic" romancing of the French hypnotists. He tells us of the bird, endowed with "*une nature eminemment électrique*," of "*l'électricité de l'air*," of "*magnétisme terrestre*," of "*l'action physiologique du magnétisme*," and the like. This means that pigeons can sense currents of atmospheric electricity or terrestrial magnetism in such a manner as to be guided by them; and this can hardly stand even as passing theory, while it remains so thoroughly proved by the experiments of Hermann,* and these have been confirmed with powerful dynamos in at least two laboratories in this country, that the magnetic field has not the least physiological influence ("*nicht die geringste Wirkung*") upon the action of any tissue or sense organ or upon the animal as a whole.

But what say homing pigeons for themselves?

Of first importance to the study of a homing instinct is the method which an animal employs to mark or locate its home. On leaving a new camp for a day's hunt in the Bad Lands, a man naturally turns about and makes a mental note of prominent buttes in the vicinity. This butte with three pine trees on top is just to the left of the gulch where the tents are pitched. "I can tell it as far as I can see it," and he strikes out. Why may not other animals adopt a similar method? Concerning bees, Thompson has observed that, "if the position of a hive be changed, the bees for the first day take no distant flights till they have thoroughly scrutinized every object in its neighborhood." This would seem to indicate a rational method of procedure.

Upon their arrival in Madison, Wis., from Worcester, Mass., the pigeons were kept confined in a large loft which had but one window, and this happened to be upon the side next another barn close by, so that it afforded no view of the surrounding country.

* Hermann. Hat das magnetische Feld direkte physiologische Wirkung? Pflüger's Archiv, vol. xliii, p. 217, 1888.

This arrangement was accidental at the time, but served very well a subsequent purpose. Five of the birds were "youngsters," and had never been liberated anywhere. On January 30 (1892), six months after their arrival, I let out these young birds one at a time, and with my wife to assist, and with spyglass, watch, and note-book at hand, we studied every act of each of the birds as long as we could keep them in sight. Since they all adopted precisely the same method of locating their loft, a description of one case will suffice.

A black Antwerp, let out at 4 P. M., flew to the ridge of a house eighty yards to the northwest, and sat for fifteen minutes, turning first this way, then that; looking eagerly the whole time; neck stretched out and head not still for a moment. This pigeon happened to alight on the north side of a chimney which came up through the ridge of the house. Its position was so close to the chimney that with stretching its neck as far as possible in both directions a considerable sector of the landscape must have been hidden from view. A few minutes after it alighted I recorded the remark, "If it is really in earnest about seeing everything in the neighborhood, it ought to go around to the other side of that chimney." Its first move, after fifteen minutes of looking, was a simple flit around the chimney. Here it stood for five minutes longer, looking attentively the whole time. It then flew a hundred yards south to the peak of a higher house, where six minutes more were given to observation from this new position. It next flew to a small, low house a hundred yards north. Here it remained scarcely a minute, whence it flew a hundred yards southeast to the peak of the highest house in the vicinity, where eight minutes more were devoted to observation. It now struck out to the southwest over a hill and grove and was lost to view until ten minutes past five, when it alighted on the loft. This flight may have been for the purpose of exploration and location, it probably was, in part at least; but leaving that out of the account, the bird spent thirty-five minutes doing nothing but look at its surroundings. The others consumed about the same time in the same way. In this we find the power to return laid in the painstaking visual localization of the home spot. One of the old birds, which escaped by accident, acted in a very different manner. After a few rapid circles, he flew straight for Madison and was not seen for three days; when, failing to find his old home in Worcester, he returned to the loft.

The next experiments were directed to determining the course taken by a pigeon in his return flight. The method employed is essentially the same as that used by Sir John Lubbock with the ants. The pigeons were taken to a convenient distance and liberated, and tracings of their flight were dotted off upon a chart of

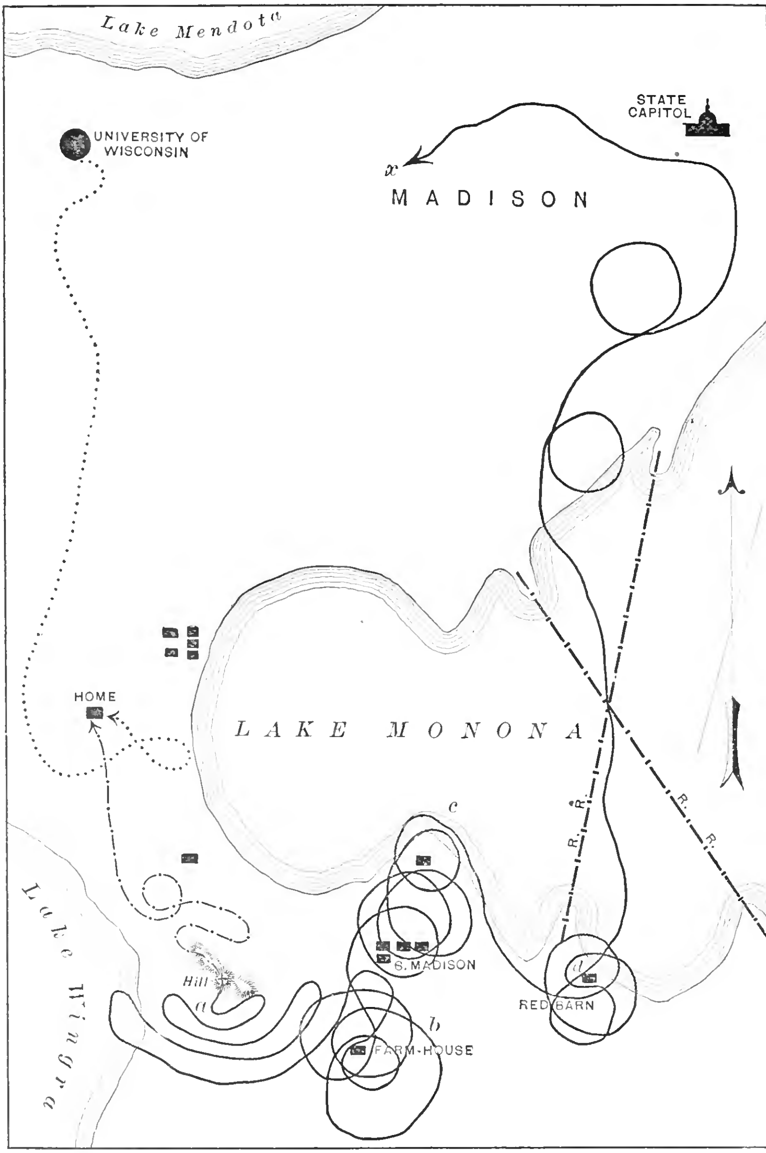

Fig. 3.

Three successive flights of pigeon No. 2.
——————— *First flight, May 29.*
—·—·— *Second " June 5.*
.... *Third " June 21.*

the country. About fifty such tracings were taken, of which a few of the more instructive are reproduced below.

A few days of freedom were allowed, in order that the birds might more exactly locate their loft; then all were again confined

in preparation for the following experiments for nearly four months.

On May 29th six pigeons were caught at random and carried in a cage, the top and sides of which were made of open-mesh wire netting to allow free vision, to the top of a hill about half a mile southeast of "home." The birds were liberated singly, and the course flown by each in returning to loft may be seen by a glance at Fig. 1. At the same time, six other birds, also taken without selection, were carried to the same place in a basket closely wrapped in a heavy black shawl. Tracings of their homeward flights are reproduced in Fig. 2.

By comparing the two figures may be seen the influence of vision upon directness of return flight. In Fig. 1, five of the birds are seen to start toward home at once; one, a young bird out of the loft for the first time, flies in the wrong direction a short distance, turns sharply about, and alights upon the first house on the line toward home. Three pigeons fly home without preliminary circling. Fig. 2 shows not a single direct course. Two begin circling in the wrong direction. One of these persists in his false bent to the extent of searching over the whole city of Madison. In the case of Fig. 1, the birds, most of them, see home very soon and fly directly to it. Fig. 2 shows more of the method which a pigeon adopts in covering unknown territory.

By comparing successive tracings of the same bird, may be seen the effect of education—i. e., improvement in good birds, failure to improve in poor ones. The first is well shown in Fig. 3, the three different lines representing three successive flights of pigeon No. 2. As this is a typical case, let us follow its development a moment. No. 2 has been carried from the loft in a covered basket to the hill half a mile distant. Not having any idea as to which direction he has been taken, he naturally starts out the wrong way. His first thought, if I may so speak, is to look around for some familiar object. So at *a* he turns about and is occupied with looking over the landscape, while he describes a number of semicircles back and forth around the place of starting. He evidently sees nothing until his widening circles bring him over a group of buildings around a farmhouse at *b*. Among these is a red barn, and close to the loft is a red house. This looks quite like home, and he swoops down toward it. On closer examination, however, he fails to discover the familiar barn, the pigeonholes, and alighting board. After making four circles low down over and among these buildings, he rises high in the air again to take another look. All to the south and west are lake and marsh and woods, with but few farmhouses visible. Toward the north he sees a cluster of houses—South Madison. He looks them over in the same way. From *c* he catches sight of another

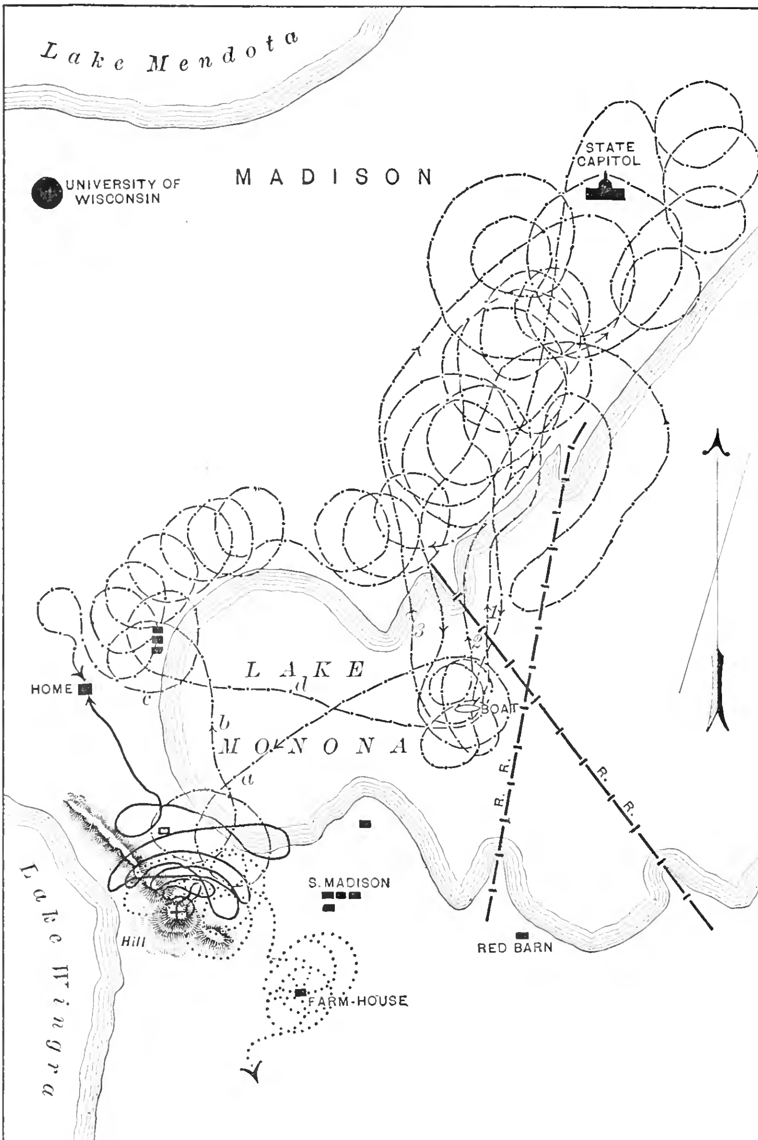

Fig. 4.

Three successive flights of pigeon No. 5.
———————— *First flight, May 29.*
——·———*Second " " 30.*
▸··········*Third " June 5.*

red barn at *d*, and goes to inspect it. Failing to find anything here, he must look farther. He has just come from the west. To the south and east are nothing but lake and woods again. To the north lies the densely settled portion of Madison. Possibly

he sees the red brick courthouse near the State Capitol. He flies thither, but on reaching the city nothing looks familiar, and he spends little time in circling over it. He is soon lost to view at x. His course thus far measures about ten miles; time, a trifle over eight minutes. He was liberated at four o'clock, and after being lost at x he was next seen as he swooped down from the west to settle upon the roof of the loft at 5.10. As it is almost certain that he flew continuously, this leaves sixty minutes unaccounted for, and at a moderate estimate fifty miles of search-line not drawn upon the chart. Were it possible to fill this in, how much "sense of direction" should we need to invoke to account for his finding home? He has flown certainly eleven miles, almost as surely sixty, to find a good-sized barn half a mile away.

The result of education is seen in his subsequent flights. A week later he flies home from the same hill in less than a minute. Two weeks later still he flies from the university almost as straight as though he did have a "sense of direction." Upon the question of education, however, we must compare Fig. 3 with similar tracings of another bird, No. 5, given in Fig. 4. In the first trial No. 5 (continuous line, Fig. 4) succeeds in reaching home from the open cage without much difficulty. Liberated from a boat on Lake Monona for a second trial, he flies wildly (the broken line seen in Fig. 4). This tracing gives an index to the harum-scarum character of the bird. Unlike No. 2, which looks over the likely places carefully and then moves on, No. 5 is careless, has no confidence in his ability, and consequently looks the same ground over and over again (see 1, 2, and 3, Fig. 4). At *a* he flies out to the familiar hill, and thence does strike out in the right direction (*b*, Fig. 4) and goes close to home (*c*), but stupidly fails to recognize it, and flies back to the boat again for a fresh start. No. 5 shows no improvement with education. When carried to the hill for a third trial (dotted line, Fig. 4), he circles for a moment, and then seeing the red barn by the farmhouse, he starts off the wrong way. This bird, with eleven others, is subsequently sent away six miles, and he alone of the twelve fails to return. No doubt there are stupid pigeons as well as stupid men.

Two points of some little interest from their bearing upon comparative psychology may be mentioned in this connection. The first is the definite reaction to color which the pigeons unquestionably gave. Until they had completed their education so far as to know the landscape pretty well, and had learned that there are many red houses and barns in the world, a red building was enough to determine their flight with almost mathematical precision. The second point is one which the Peckhams have noted

with reference to wasps*—viz., if wasps are taken away from their nests and liberated over water, they fly toward the nearest land, although their nest is in the opposite direction. In liberating the pigeons from the boat this reaction was tested a great many times and never failed.

The tracings speak too plainly for themselves to require further comment. If any are able to extract "direction-sense consolation" out of them, they are entirely welcome to it.

The criticism naturally arises at this point that the pigeons are not trying to find home at all. They may be flying for pleasure or exercise. Two things may be said in reply: First, theories of "direction-sense" have been based upon the air-line course which a pigeon has been supposed to take, "after getting his bearings," from place of liberation to loft. This, as we have seen, comes only after training. In the second place, after a little observation, it is easy to distinguish from the sportive cavortings for pleasure the eager darting flight of search.

If, however, they fail to give evidence of "direction-sense," may not such tracings show something of even greater importance? All animals, from amœba to man, spend a good share of their time searching for something or other. May there not be a fundamental logic of search as universal as the search itself? Naturally, if this is so, those animals whose life depends most closely upon finding the objects of their search would come to have the power and the logic of search most highly developed. We may then ask, What is the path or curve of logical search? It could hardly be a straight line, since the effort necessary to search must have a tendency to cause any animal to search over nearest ground first, inasmuch as turning or looking around is easier than moving the body ahead as far as the animal is able to see or feel ahead. We see this exemplified in the circling of hawks and the circling of dogs when starting out to cover a field. It could not be a circle, however, in case of an animal with memory to avoid covering the same ground twice.

To test the matter experimentally, a number of people kindly drew for the writer the path each would take to find an object, the proximity or direction of which is unknown. The object is supposed to lie upon a uniform field. Types of the curves handed in are given in Figs. 5 to 8. Undoubtedly the logical curve is the one submitted by Prof. Story (Fig. 5). It will be recognized to be a peculiar spiral, the involute of a circle, the characteristic of which is that the convolutions are always the same distance apart. This distance will be, of course, twice the distance at which the object is visible. The curve given by the majority is drawn in

* *Loc. cit.*, p. 17.

Fig. 6. This is a shade less ideal. The searcher, supposing him to be at the center, first looks around as far as he can see, then goes straight out twice the distance at which the object is visible, and begins following circles, each one being twice the visible distance from every other. A number of rectilinear figures were

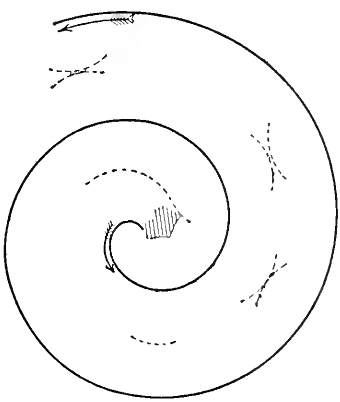

Fig. 5

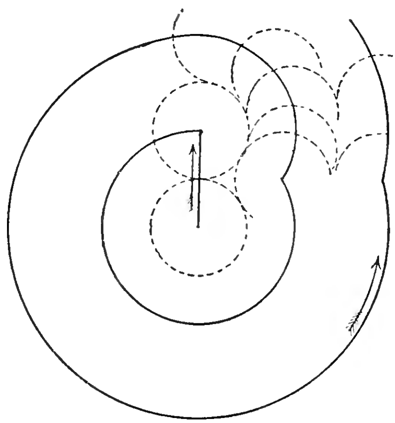

Fig. 6

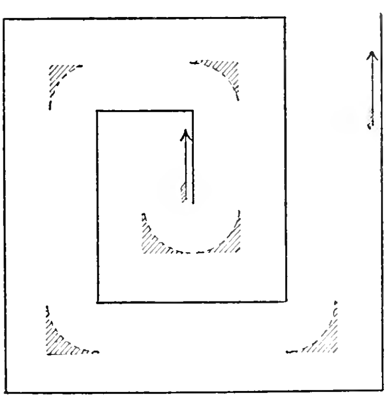

Fig. 7

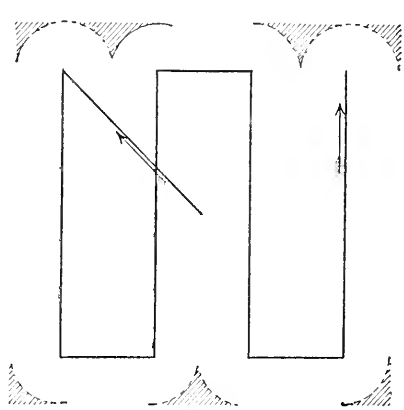

Fig. 8

Fig. 5. Involute of a circle, the figure suggested by Professor Story as the ideal curve of search.

Fig. 6. Curve of search given by a number of persons.

Figs. 7 and 8. Rectilinear search lines.

The shaded portions in Figs. 5 to 8 represent parts of the field not visible without looking backward or deviating from the search curve. Dotted arcs indicate limit of vision.

received, types of which are reproduced in Figs. 7 and 8. These are a stage above the fundamentally logical. They clearly belong to the realm of the practical. We might call them "Yankee" search curves. They are practical, of course, because it is easier to follow a straight line than a curve.

A simple experiment was next devised, in which a person

actually sets out to find a red tennis ball on a grassy lawn, his steps being plotted while he is making the search. The ball was placed in all cases so that it could be seen from a distance of ten steps and at a uniform distance forty steps from the center stake, in order that the tracings of different persons could be compared as to time and length of course traversed.

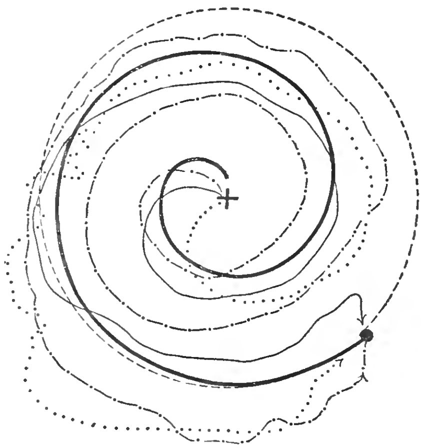

Fig. 9.

+ *Starting point.*
— — *40 step circle*
▬▬ *Ideal curve.*
—— *Path of T. P. H. 4 minutes.*
—·— " " *T. L. B. 7* "
.... " " *L. W. 5* "

No attempt was made to do more than was necessary to obtain a suggestion which might serve to indicate the logic and method of the pigeons. In all only sixteen tracings were taken, and this number includes one experiment on a shepherd dog. Of the whole number, ten conform more or less closely to Prof. Story's curve. Three of the best of these are reproduced in Fig. 9. Two correspond evidently to the circular type (Fig. 6). These are given in Fig. 10, together with the only one which is in any degree rectangular, the "Yankee" type, and this was not made by a Yankee at all, but by an Irish boy twelve years of age. Three of the curves are hardly susceptible of logical classification.

A point of interest in this connection attaches to the dotted line in Fig. 9. This represents the path of L. W., the university carpenter, a man sixty-five years old, who had worked at his trade of straight lines and right angles for forty-five years. I had expected a typical rectangular curve. Instead he gave an ideal spiral. After finding the ball, however, he volunteered the following suggestive remark: "After I got started, I thought, if I was going to do it again, I would go at it on the square. I started out," he added, "before I thought." Thus instinctive logic won the day against forty-five years of special training.

If instinctive, however, this logic should be found almost as well developed in children as in adults. Accordingly, spicing the ball with candy or a small coin, several experiments were tried upon children from three to twelve years of age. In general the above statement was supported; but two of the number, aged respectively three and six, failed to show anything like the amount of search-logic possessed by most of the pigeons or the shepherd

dog. One of these, the devious path of a bright six-year-old Irish girl, is reproduced in Fig. 12. Lubbock's ants might be pardoned for smiling should they chance to see this tracing.

The search line of an intelligent dog is given in Fig. 11. His eyes were covered, but he evidently had a strong impression that the ball had been thrown in the direction I happened to be facing. Resemblance between this and tracings of a number of the pigeons is quite evident.

The bearing of the above upon the problem of search as exhibited by the homing pigeon requires no detailed statement. In a word, the pigeon uses a logic of search which is common to animals generally, and there is no evidence that he employs anything else. His power of rapid and prolonged flight makes it possible for him to spin his search lines over vast areas and so carry them beyond our vision and lift them into the realm of mystery.

In such cases the time consumed furnishes an important check. Of a large number of birds sent away by rail for longer flights, not one made the return trip in less time than would have enabled him to fly on the involute of a circle from the place of liberation. This refers to "first flights." The best time made was twenty-six miles in five hours and nine minutes. Three other birds liberated at the same time failed to return. Letting the distance to which a prominent landmark is visible be three miles, a fair estimate for pigeons with some training and over broken country, the least length of an involute of a circle which would bring a bird from a distance of twenty-six miles to within sight of the loft is two hundred and nineteen miles. In five hours it is not likely that the pigeon flew less than two hundred and fifty miles.

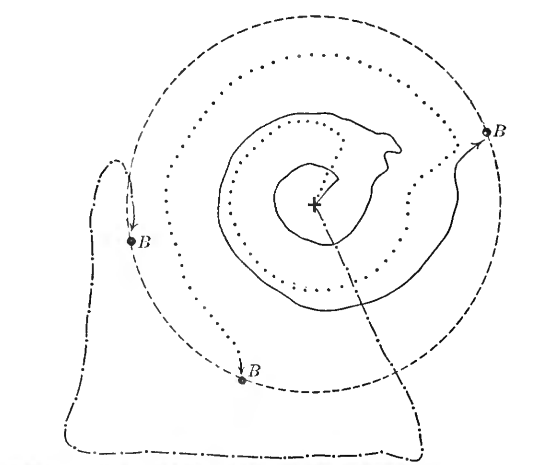

Fig. 10.

Three search lines, circular and rectangular types. + Starting point. The ball is shown at different points on — —, the 40 step circle. ——— Fence.

One thing which causes the search lines of the pigeons to swerve from the ideal curve of search upon a uniform field is that the field in their case is never uniform. A house of any kind, especially a red building, or, upon the lake, nearness to land,

furnish elements of greater probability and determine search in that direction. To obtain an ideal curve for a uniform surface it would be necessary to liberate the pigeon on a Dakota prairie or in mid-ocean, where no break in the landscape is visible even from an altitude of a thousand feet. It is not, however, difficult to find approximations to the ideal in the widening circles and the flights in different directions to be seen in Figs. 1 to 4.

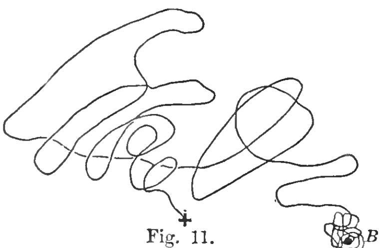

Fig. 11.
Search-line of a shepherd dog.
+ *Starting point. B. Ball.*

It may seem to some that in denying a "sense of direction" and affirming a logic is like jumping from the frying pan into the fire. The only thing to be said on this point is that we do find evidence for search-logic and no evidence for "direction-sense." And further, in the one case we explain the phenomena by something fundamental in animal life, which we do know something about; whereas on "sense-direction" grounds we are explaining the partially known by the absolutely unknown.

An instance of quite a different sort from the above stood in the writer's mind as almost conclusive proof of sense-direction powers for a number of years. It may be briefly stated as follows:

A large Maltese tomcat once joined, on his own invitation, an evening rowing party on one of the Wisconsin lakes. It was a sultry summer night, as dark as a moonless night can be. Not a breath of air was stirring. We rowed nearly due north, straight out toward the middle of the lake, which is something over two miles wide. For some time Tom purred and made himself generally agreeable from one end of the boat to the other; but at last he grew restless and extremely anxious to get home. He would climb out to the end of the boat and, stretching his head toward home, mew almost continuously. We amused ourselves for some time by turning the boat slowly round and round, first one way then the other, to see if we could throw Tom off his bearings; but all to no effect. Whether right side, left side, bow or stern, Tom was always on the part of the boat nearest home, and straining as far as he could in that direction. Fully a mile from any shore, how could he tell which shore was which? But few lights were visible, the lake is thickly wooded, and the cottages stand well back among the trees. Not one in the party could recognize the lights of our own group of cottages. And no one but myself and cat had any idea which way to go for home. For my part, I had kept an eye out for the north star. But what

did Tom do for his bearings? Could it be that through such inky darkness he could see enough of the shore to distinguish anything on it? This was easily tested. Taking a heavy blanket

Fig. 12.

Search line of B. H., a 6 year old girl
+ Starting point. B, ball on 40 step circle.
T trees. E, terminus. Time, 75 minutes.

shawl, which was serving as cushion, we wrapped Tom up in a number of thicknesses of it and one of the party held him in her lap while the boat was slowly turned around. This was of no use. On being released Tom started, with never a mistake and without

the slightest hesitation, toward the end of the boat nearest home. To make doubly sure that vision was impossible, Tom was wrapped up and gently held flat in the bottom of the boat. This made no difference. Whether the boat was turned by a single stroke, as on a pivot, or rowed slowly around in a circle, the result was always the same. Tom went, without hesitation, invariably to the end or side of the boat nearest home.

Members of the party were blindfolded and required to guess whether the boat was turned or allowed to stand still, or was rowed in a straight line or in a circle; and it was an even chance whether they guessed right or wrong. Tom had a far better head for direction than any of us.

It was suggested that possibly a gentle current of air might be serving Tom as a direction-constant. This, however, could hardly have penetrated the shawl, and certainly not when in the bottom of the boat. Still, might not such a current be conveying odors imperceptible to man, but not to a cat? None of our number could feel the slightest breath of air on our faces, and even with the moistened finger held above the head, it was impossible to detect any flow of air. Might not then a wake of odor hanging in the air over our course serve as the needed direction-constant? This could hardly be, since we had rowed about so much that anything of the sort must have become thoroughly diffused.

Sight, smell, and touch would thus seem to be inadequate to explain the feat. Hearing still remains. But not a sound from any shore broke the silence. No town or city was near to furnish a roar, hum, or series of sounds of any sort. We could hear no bands of music, nor even the occasional bark of a dog. For minutes at a time we could hear absolutely no sound. And yet, may it not be that Tom heard every note some Tabby was making on the shore a mile away? If we were dealing with a sense as delicate as this, further experiment was useless. We had no means of stopping Tom's ears, and no microphone with which to explore the darkness for sounds inaudible to our ears.

The above explanation is open to serious objections. The chief of these, aside from such acuteness of hearing, is the fact that at no moment during the hour or more we were experimenting with him did Tom show the least doubt as to his direction. The auditory constant, therefore, must have been uninterrupted, and supposing it to have been the mewing of some cat, or cats, we all know what the possibilities are. At the time, the writer was quite convinced to the contrary, but several years afterward an incident occurred which threw the balance of probability strongly toward the side of the auditory explanation.

While hunting deer in Montana, I once lay on the top of a hill watching a doe as she kept guard while her two fawns were feed-

ing. The three deer were in about the middle of a level grassy plain fully half a mile from where I lay. I focused my field glasses on the group, and soon became much interested in the alertness of the doe. Not for an instant did she show the slightest relaxation of attention. Generally, under such circumstances, a deer is seen to sniff the air in every direction, but this time no air was stirring, and the main feature of the watching was the constant movement of the long ears. At a slight noise, occasioned by my change of position, a noise not even noticed by myself, I was surprised to see the doe start, turn about, and point her ears in my direction. After a minute's silence, her attention was attracted elsewhere, and this time I made the lowest possible "ahem!" Again both ears and head were directed toward me. And so in turn for an hour, I tried all manners of slight sounds, low whistles, snapping the fingers, tapping my rifle stock, scraping the grass with my foot; all were followed, with the precision of the response of a strychnized frog, with the attent turning of the ears in my direction. The writer at that time was not familiar with any special apparatus for the purpose, and so can give no exact measure of the sounds employed. I can only say, however, that they were so slight that, if a deer could hear them half a mile away over a grassy plain, it might be an easy matter for a cat to hear a moderately loud "mew" a mile away, over the surface of water on a still night.

It is not rare to find great differences in keenness of sense among different men. These differences become emphasized by use, as we find in the sight of the sailor or savage, or in the touch of the blind. There is every reason why we should expect to find such differences much more pronounced between different species of animals. So marked, in fact, do they appear that the temptation has always been to declare them differences in kind. Before doing this, we ought to make a beginning, at least, to learn the possibilities of the senses as they exist in different animals. So far as the writer has gone in this direction, he is content to conclude that they are using the ordinary senses, highly refined, it may be, by generations of development; and the every-day logic which tells man and animal alike that the shortest path between two points is a straight line.

In the course of his journeyings in the Pamirs, the Earl of Dunmore came upon a beautifully clear sheet of water, out of which the Yambulak River flows. It is surrounded on three sides by stupendous cliffs, rising sheer up two thousand feet from the water's edge, with one huge glacier standing out in bold relief in the middle of them, "which doubtless," he says, "gave the water the most beautiful emerald hue I ever saw." The altitude of the lake is 15,800 feet, and the summit of the Yambulak Pass beyond it is 16,530 feet high.

INCIDENTS OF CAMBODIAN LIFE.

By ADHÉMARD LECLÈRE.

THE Cambodian woman carries her child a-straddle of her left hip, with her arm passed round its little body. She rarely leaves it, except to attend to something in the house or the yard; and this custom of carrying the child thus is followed up so constantly that one shoulder of the woman finally becomes higher than the other. When the mother goes to the rice fields, or to the village, or so far that this method of carrying it becomes fatiguing, she puts the child into a shawl and carries it on her back. In the house, the baby sleeps on a mat, on which the mother has thrown an old *sampot* (cloth), so as to raise its head a little higher than the body, or in a shawl hung as a hammock, or in a hammock made of a quartered bamboo, the ends of which are whole. The child is naked, but when it is cold in the morning it is given a shawl or a piece of *sampot* for a covering, and is carefully covered at night. Boys go naked till they are six, seven, or eight years old, but after that age they put on a *sampot;* girls are dressed when they are four years old. In some parts of the country the children, otherwise nude, wear a small plate of ornamented silver in front. It is also a general custom to hang pieces of money, ancient or modern, from the neck, and rings of silver or gold on their arms and ankles. Mothers too poor to give them jewels tie a piece of cord that has been blessed by a wizard around their necks. The ears of girls are bored very early, sometimes even before they can walk, and cotton threads are inserted, to be replaced in time by gold or silver earrings. The heads of children are shaved often—to harden them, the Cambodians say—but at the age of three or four years a circular tuft is permitted to grow on the top of the head, and when the hair in this spot has reached a certain length it is bound and fastened with a pin of gold, silver, copper, or wood.

Cambodian children, it seems to me, are not as precocious as European children, favorable as the climate is to them. Thus we do not find in Cambodia (or in Annam, Tonquin, or Cochin China) babies beginning to walk in their tenth or ninth month, and I have never seen any who could speak correctly in their third year, although in France we have little gentlemen and young dames who are in their second year already very talkative and very important personages. The children of the Cambodians are generally pretty till they are about twelve years old, with more regular features than they will have afterward; and it is pleasant to find in them some of the resemblance to their Indian ancestors, which has been absorbed with the features of a more numer-

ous and less gifted race. The children have prodigious memories, and I have often been surprised at the facility with which, without giving themselves much trouble, they learn in a few months the Roman characters and French writing and language. The faculty of learning foreign languages persists in the adult; the grown men, our servants, persons living near us, learn enough of our language to make themselves understood, while we have to take nearly two years to learn, without study, as much as they. The children are very intelligent, but I have been assured, and am disposed to believe it, that their intelligence, if it does not remain stationary, becomes less active after their fifteenth year. It seems as if a little darkness came over their minds when their primitively pure features are deformed and they lose their atavistic resemblance to their ancestors.

They are docile, obedient, quiet in their sports, and very respectful to their parents. They are never seen presenting anything to their father with one hand, negligently or hurriedly, but well-brought-up children, observing well the old customs, offer the object requested with both hands, gracefully bowing. They do not eat with their father unless he invites them, but with their mother and her women, in whose charge they are. They do not sit with their father or on the same level, because it is proper for children to be always placed below their father. They have likewise a great respect for their mother, but it is more intimate than that for their father, who is also master of the house, and is designated by a word that means master and prince. Respect for the mother, while less demonstrative, is more durable; it continues in sons and daughters long after their marriage, and with grand mandarins and in the palace assumes a really touching appearance of deep veneration. I was told that the king never came into the presence of his mother without saluting her on his knees, and without offering her the homage which his mandarins offered to him.

At eleven years for the girls and thirteen years for the boys—or sometimes thirteen years for the girls and fifteen years for the boys, but never twelve or fourteen years, for years of even numbers are considered unlucky—the ceremony of cutting the hair is performed; that is, the shearing of the tuft which we have seen is tied and fastened with a pin. This ceremony of Brahmanic origin, a kind of sacrament instituted by Siva, which the Hindus call *kesenta*, takes place usually in the anniversary month of the child's birth, on the first day of the decrease of the moon, in the presence of all the relatives and the friends and clients of the family. The festivals already mentioned in connection with the cutting of the hair are repeated in full, but this time it is the turn of persons of higher importance to perform the ceremony. This festival is the festival of puberty. From its celebration the child

lets his hair grow as he desires to wear it. The girls cease to play and laugh with the boys, observe a more strict and graver walk, and more usually keep to the house.

Betrothals take place, in the presence of both families, one or two years before the marriage. They consist of a repast participated in in common by all the connection, and in the proclamation of the engagement which the two families have made to unite their children. As the diviners have named the most favorable day for the betrothal, they also designate the most suitable one for the celebration of the marriage. This ceremony takes place, like the former one, in the presence of both the contracting families, the kindred, and the neighbors. It includes presents made by the groom to the parents of the bride, the offer of betel and areca nuts, the invocation of ancestors, and the *chang day* or binding of the wrists, a curious ceremony which all the parents perform by attaching cotton threads around the left wrist, in token, I suppose, of the bonds which will hereafter exist between the members of the two families. Besides this a present of *sampots*, silver bars, or money is made by the friends of the groom to the mother of the bride, in consideration of the care she bestowed on her daughter in her infancy. This has been improperly, perhaps, styled the price of the girl; if not a proof of her purchase by the groom, it is certainly a relic of the customs of a period when the woman was bought by the one who married her, and the price paid to the mother. I say to the mother, not to the father, because the present is in reality made to her, and not to the head of the family; a very important fact, which with others that I shall adduce attests to the existence in the past of the matriarchate among the Khmers.

I find traces of this state of society in this fact, that the price of the "nursing milk," as it is called, is paid to the mother; and also in the much more lasting and profound respect had by the son for his mother, and in the general and uncontested principle that the woman put away by her husband has the right to take her children with her. I might add, too, in support of this view that it is the custom, always observed, for the father not to consent to a marriage which the mother opposes, and not to pledge a child without the consent of its mother; then there is the instinctive horror, much more marked than when the father is the victim, which Cambodians feel at the thought of a child beating its mother. One of the most conclusive proofs appears in the word for cousin-german, which when analyzed means brother-grandmother, or brother by the same grandmother, but never brother by the same grandfather. This affords an almost incontestable trace of an ancient social *régime* when relationship followed the female line.

The Cambodian woman occupies a dignified position in the house of her husband. He owes her respect and gives it, and is not rude or violent in her presence. He can put her away, but she can also claim a divorce at law. She can go to law without the consent of her husband, when she must be supported by a relative, or, if she has none, by a respectable neighbor. If she is summoned to court, she can oblige her husband to go with her, under penalty, if he fails to go, of his losing his rights over her; and she can leave him without his having any right to complain or to claim reparation. He can pawn her or sell her as a slave if she consents, but he can not dispose of himself in such way without her approval. The woman can have but one husband, and he can not take a second wife or any additional one without the consent of his first wife. The first wife is called the first wife, the second the middle wife, and the third the end wife; those that follow are concubines. They are all hierarchically subordinated one to the other, but the great wife, the true wife, is mistress of the house, and the others are only her followers and servants. If one of these encroaches upon her prerogatives, she can punish her; if she seeks to seduce the husband and supplant the first wife in his heart, she can call her guilty rival before the court and get judgment against her. The first wives sometimes select the other wives for their husbands, often choosing such as will be agreeable companions to themselves; and women are numerous who have been able to exert such influence over their husbands or exercise such power in the house as to prevent the introduction of any other wives.

Cambodian maidens rarely go astray, and infanticide is absolutely unknown in the country. Mothers are anxious to have children, and are not afraid of any number of them. A woman who has no children after several years of marriage is unhappy over the fact, and her fellow-women sympathize with her for it.

The people are brave, willing to run considerable dangers for a small reward, and are valiant in action; but they are superstitious, and believe in ghosts, evil spirits, witches, and witchcraft. They offer worship to genii and invoke them, good and bad alike, when they are afraid or in need. It is not rare to find in the corner of a rice field a little straw mat inclosing a fragment of a sculptured prayer from some ancient Khmer monument, or simply an ordinary stone. They believe that the *arac* dwells in this stone, give it homage, and burn fragrant sticks before it, which they plant in a piece of banana stem, or a small basin, or in half a cocoanut filled with sand. They also render a secret worship to *lingams* derived from the Brahmanic epoch which have been concealed for centuries in the depths of natural grottoes, without knowing what these stones represent.

The Khmers believe in unlucky places, which one can not inhabit or cultivate without exposure to death; in places haunted by evil spirits, which one can not visit without perishing; in stones or statues which one can not touch without falling sick; and places which one can not pass without making an offering. There are in the province of Kampot a mountain at the foot of which the Chinese dies who attempts to pass it, and a defile where it is necessary to alight from one's horse or carriage and cast an offering of branches upon a cup placed at the fork of two roads, saying, "I offer thee a parasol." A statue of a woman of the Brahmanic period stands on a river island in the province of Sambaur, before which women can not present themselves, but which men are permitted to caress in order to insure the fidelity of their wives.

Many women and children wear cords which they buy of the witches, in order to preserve them from certain maladies; and from these sometimes hang little leather cylinders which are believed to be very effective. In certain provinces of Upper Cambodia characters are tattooed on the breast as preservatives against attacks by the tiger and panther, and against snake bites.

The Cambodians are usually pleasantly disposed, but very revengeful for injuries. Theft is common, but less so than in Cochin China. Assassination does not excite any great degree of attention or cause any deep remorse in the murderer. They bear pain with much courage; but illness reduces their energy to a very low degree. Prisoners condemned to death by decapitation march courageously to punishment, smoking their last cigarette, without bravado and without weakness.

The paddy gathered and deposited in the granary is protected by a stone for which they have a superstitious regard; and they employ the *achars*, the religious *literati* of the village, to read prayers and invocations over the store.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

The latest report of the directors of convict prisons in England gives satisfactory evidence that serious crime is perceptibly diminishing throughout the country. Thus, during the five years ending in 1859, when the population of England and Wales was 19,257,000, the sentences to penal servitude numbered 2,589. The years 1885 to 1889 showed the much lower total of 945; the population then being 27,830,179. Since that period a further decrease has been registered. A reduction in the number of young convicts has been remarked. Even as late as 1887 it stood at 3·2 per cent of the whole prison population. In 1892 it was 1·2 per cent. These observations agree with the statement that the diminution in the whole amount of criminality is mainly attributable to a decrease in the number of young offenders, while the proportion of older delinquents has increased.

THE ICE AGE AND ITS WORK.

By ALFRED R. WALLACE, F. R. S.

ERRATIC BLOCKS AND ICE-SHEETS.—(*Continued.*)

II.

WE must now consider briefly the distribution of erratics in North America, because they present some peculiar features and teach us much concerning the possibilities of glacier motion.

An immense area of the Northeastern States, extending south to New York, and then westward in an irregular line to Cincinnati and St. Louis, is almost wholly covered with a deposit of drift material, in which rocks of various sizes are imbedded, while other rocks, often of enormous size, lie upon the surface. These blocks have been carefully studied by the American geologists, and they present us with some very interesting facts. Not only are the distances from which they have been transported very great, but in very many cases they are found at a greater elevation than the place from which they must have come. Prof. G. F. Wright found an enormous accumulation of bowlders on a sandstone plateau in Monroe County, Pennsylvania. Many of these bowlders were granite, and must have come either from the Adirondack Mountains two hundred miles to the north, or from the Canadian Highlands still farther away. This accumulation of bowlders was seventy or eighty feet high, and it extended many miles, descending into a deep valley one thousand feet below the plateau in a nearly continuous line forming part of the southern moraine of the great American ice-sheet.

On the Kentucky hills, about twelve miles south of Cincinnati, conglomerate bowlders containing pebbles of red jasper can be traced to a limited outcrop of the same rock in Canada to the north of Lake Huron, more than six hundred miles distant, and similar bowlders have been found at intervals over the whole intervening country. In both these cases the blocks must have passed over intervening valleys and hills, the latter as high or nearly as high as the source from whence the rocks were derived. Even more remarkable are numerous bowlders of Helderberg limestone on the summit of the Blue Ridge in Pennsylvania, which must have been brought from ledges at least five hundred feet lower than the places upon which they now lie. The Blue Ridge itself shows remarkable signs of glacial abrasion, in a well-defined shoulder marking the southern limit of the ice (as indicated also by heaps of drift and erratics), so that Mr. Wright

concludes that several hundred feet of the ridge have been worn away by the ice.

The crowning example of bowlder transportation is, however, afforded by the blocks of light gray gneiss discovered by Prof. Hitchcock on the summit of Mount Washington, over six thousand feet above sea-level, and identified with Bethlehem gneiss, whose nearest outcrop is in Jefferson, several miles to the northwest, and three or four thousand feet lower than Mount Washington.

These varied phenomena of erratic blocks and rock striations, together with the enormous quantity of bowlder clay and glacial drift spread over the whole of the Eastern States, terminating southward in a more or less abrupt line of mounds having all the characteristics of an enormous moraine, have led American geologists to certain definite conclusions in which they all practically agree. It may be well first to give a notion of the enormous amount of the glacial *débris* under which a large part of the Eastern States is buried. In New England these deposits are of less thickness than farther south, averaging from ten to twenty feet over the whole area. In Pennsylvania and New York east of the Alleghanies the deposits are very irregular, often sixty or seventy feet thick and sometimes more. West of the Alleghanies in New York, Pennsylvania, and Ohio the thickness is much greater, being often one hundred and fifty or two hundred feet in the wide valleys, and forty or fifty feet on many of the uplands. Prof. Newberry calculates that in Ohio it averages sixty feet deep over an area of twenty-five thousand square miles.

The direction of the striæ and of the traveled bowlders together with the form of the great terminal moraines show that there must have been two main centers of outflow for the ice-sheet, one over Labrador, the other over the Laurentian Highlands north of Lake Superior. The southern margin of the drift may be roughly represented by portions of circles drawn from these two points as centers. The erratics on the summit of Mount Washington show that the ice-sheet must have been a mile thick in its neighborhood, and much thicker at the centers of dispersion, while the masses of drift and erratics on plateaus two thousand feet high near its southern boundary indicate a great thickness at the termination. The Laurentian plateau is now about two thousand feet above the sea-level, but there are numerous indications from buried river channels, filled with drift and far below the sea, which lead to the conclusion that during the Ice age the land was much higher. That snow can accumulate to an enormous extent over land of moderate height when the conditions are favorable for such an accumulation is shown by the case of Greenland, the greater part of whose surface is a vast

plateau of ice flowing outward by numerous glaciers into the sea. The center of this plateau where Dr. Nansen crossed it was over nine thousand feet above sea-level, and it may be very much higher farther north. It, therefore, seems probable that the great American ice-sheet was, at least, as high, and perhaps much higher, and this would give sufficient slope for the flow to the southern border. Of course, during the successive stages of the glaciation there may have been numerous local centers from which glaciers radiated, and during the passing away of the Ice Age these local glaciers would have left striæ and other indications of their presence. But so much of the area covered by the drift—all, in fact, south of the New England mountains and the Great Lakes—is undulating ground, hill, valley, and plateau of moderate height, that here all the phenomena seem to be due to the great confluent ice-sheet during the various phases of its advance and its passing away.

Sir Henry Howorth, in his very instructive work already quoted, denies the existence and even the possibility of such ice-sheets as those here indicated as having occurred in North America and Europe. He maintains that ice of the requisite thickness could not exist, as it would be crushed or liquefied by its own weight; and further, that if it existed it could not possibly move over hundreds of miles of generally level country, passing over hills and valleys and carrying with it, either on its surface or in its lower strata, the enormous quantity of bowlders, gravel, and clay which we find everywhere overlying the present surface of the ground. No doubt the difficulty does seem an enormous one, but I think that it can be shown to be not so great as it seems; and it is certainly by no means so insuperable as that of the apocryphal floods, or "waves of translation" as they have been called, to which he imputes the phenomena. He asks us to believe in one or more gigantic waves sweeping over Eastern North America, carrying bowlders to the summit of Mount Washington, nearly six thousand feet high, scattering others over an area which is roughly one thousand miles from east to west and six hundred from north to south, and in its course producing those wonderful striæ, grooves, and furrows in the rocks photographed in the American reports, and the enormous extent of smooth and rounded rock surfaces that is found over this wide area. Besides these there are two other phenomena absolutely inconsistent with a diluvial agency. One is the enormous deposits of fine compact clay bearing rounded and scratched stones thickly scattered through it, utterly unlike any deposit produced by water, which would necessarily leave the stones hundreds of miles behind the place to which the fine mud would be carried. The other is the existence of well-defined heaps, mounds, and ridges of gravel and

bowlders, forming the terminal moraine of the ice-sheet. This is exactly similar in general form and structure to the moraines left by the old Alpine or North British glaciers, and if the former could have been produced by a flood so could the latter. But the American terminal moraine runs across the country almost irrespective of its contour, and is often as well marked on plateaus as in valleys and on the intermediate slopes. Moreover, this moraine often lies on the southern slope of the hills draining toward the Mississippi Valley; and we are asked to believe that a flood vast enough to carry gravel and rocks for hundreds of miles to such a position, left them all stranded on a slope down which it must have been rushing with increased velocity and without hindrance toward the Gulf of Mexico! So far as I know, Sir Henry Howorth is absolutely alone among living writers in his diluvial theories, and I only give this brief statement of their overwhelming impossibilities because his book is so interesting, and his assertions that his theory explains *all* the facts are so confident and so often repeated that they are likely to confuse the judgment of readers who have not paid special attention to the subject.

Returning to the main question, of the possibility of glaciers or ice-sheets moving over long distances of generally level ground with intervening hills and valleys, there is an important piece of evidence, the bearing of which appears to have been overlooked by objectors. The former existence of the great Rhone glacier carrying erratics to the slopes of the Jura from beyond Geneva on the southwest to Soleure on the northeast, is universally admitted. This glacier passed out of the gorge between the Dent du Midi and the Dent de Morcles, and a little below St. Maurice enters on the alluvial plain which extends to the lake. From this point to Geneva, a distance of about sixty miles, may be considered a level plain, the descent into the lake being balanced by the ascent out of it. Yet it is admitted that the glacier *did* move over this distance, since erratics which can be traced to their source on the left of the valley below Martigny are found near that city. But the main part of the glacier curved round to the right across the Lake of Neufchâtel, and extended at least as far as Soleure, a distance of about ninety miles. To do this it must have ascended five or six hundred feet to the country around Fribourg, and before reaching Soleure must have passed over a hill three or four hundred feet higher. Yet on the flanks of the Jura above Soleure there are erratics which have been carried on the surface of the glacier from the east side of the valley below Martigny, and close to Soleure itself there are remains of a terminal subglacial moraine of compact bowlder clay. Sir Charles Lyell describes this as—

an unstratified mass of clay or mud, through which a variety of angular and rubbed stones were scattered, and a marked proportion of the whole were polished and scratched, and the clay rendered so compact, as if by the incumbent pressure of a great mass of ice, that it has been found necessary to blow it up with gunpowder in making railway cuttings through part of it. A marble rock, of the age of our Portland stone, on which this old moraine rests has its surface polished like a looking-glass, displaying beautiful sections of fossil shells, while occasionally, besides finer striæ, there are deeper rectilinear grooves, agreeing in direction with the course in which the extinct glacier moved according to the theory of M. Guyot before explained.*

It is evident that, to have produced such effects as are here described, the glacier must have extended much beyond Soleure, and have been very thick even there. It thus proves to demonstration that a glacier *can* travel for a hundred miles over a generally level country, that it *can* pass over hills and valleys, and that, even near its termination, it *can* groove, and grind, and polish rocks, and deposit large masses of hard bowlder clay. And all this was done by a single glacier issuing from a comparatively narrow valley, and then spreading out over an area many times greater than that of its whole previous course. In this case it is clear that such a vast mass of ice, constituting a veritable ice-sheet on a small scale, could not have derived its motion solely from the push given to it by the parent glacier at St. Maurice. Neither could gravitation derived from the slope of the ground have affected it, for it passed mostly over level ground or up slopes, and its termination at Soleure is actually nearly two hundred feet higher than its starting point at the mouth of the valley below St. Moritz! There remains as a cause of motion only the slope of the upper surface of the glacier, the ice slowly flowing downward, and, by means of its tenacity and its viscosity on a large scale, dragging its lower portion still more slowly over the uneven or upward sloping surface. This mode of motion will be discussed later when dealing with the origin of lake-basins.

No doubt at this epoch of maximum glaciation the ice-sheet extended over the whole country between the Bernese Alps and the Jura, and the downward flow of the lateral glaciers along the valley of the Sarine, Aare, and other rivers flowing toward Soleure greatly assisted the general onward motion. But the fact remains, and it can not be too strongly insisted on, that here we have a veritable ice-sheet moving over hill and valley, carrying on its surface quantities of erratic blocks, rounding, striating, and polishing the rocks over which it passed, and with the material thus crushed and ground away forming great deposits of bowlder clay, much of which still remains, although enormous quantities

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* The Antiquity of Man, fourth edition, p. 349.

must have been carried away by the rivers to the lowlands of Europe and to the sea. The fact is therefore demonstrated, and is implicitly admitted by the most conservative of glacialists, that in this case an ice-sheet *has* moved onward over a hilly plateau for nearly a hundred miles, even when its terminal moraine is at a higher level than its exit from the mountain valley where it had its origin.

It will now be well briefly to sketch the distribution of erratic blocks in Great Britain, and the conclusions to be drawn from them as to the former existence of an ice-sheet under which the greater part of our islands was buried.

Every mountain group north of the Bristol Channel was a center from which, in the earlier and later phases of the Ice age, glaciers radiated; but many facts prove that during its maximum development these separate glacier systems became confluent, and formed extensive ice-sheets which overflowed into the Atlantic Ocean on the west, and spread far over the English lowlands on the east and south. This is indicated partly by the great height at which glacial striæ are found, reaching to twenty-five hundred feet in the Lake District and in Ireland, somewhat higher in North Wales, and in Scotland to nearly thirty-five hundred feet; but also by the extraordinary distribution of erratic blocks, many of which can be traced to localities whence they could only have been brought across the sea. The direction of the glacial striæ and of the smoothed side of ice-worn rocks also indicate that the shallow seas were all filled up by ice. The Outer Hebrides, for example, are all ice-ground from the southeast and east, showing that the deep channel of the Minch was filled up, and that the Scotch ice-sheet flowed completely over the islands. On all sides of Ireland, except the southern coast, the ice flowed outward, but on the northeast the flow was diverted southward, and on the extreme north, westward, by the pressure of the overflowing ice-sheet of Scotland which here encountered it. In like manner, the ice-marks on the east coast of Ireland and the west coast of Wales are diverted southward by the mutual pressure of their ice-sheets, which, together with that of the west of Scotland, filled up St. George's Channel. That such was the case is further proved by the fact that the Isle of Man is ice-ground in a general direction from north to south, and to the summit of its loftiest mountains, which rise to a height of over two thousand feet. This could only have been done by an ice-sheet flowing over it, and this view is further supported by some most remarkable facts in the dispersal of *local* erratics. These are always found to the south of the places where they occur *in situ*, never to the north; and, what is still more noteworthy, they are often found

far above the native rock. Thus, bowlders of the peculiar Foxdale granite are found about fourteen hundred feet higher than the highest point where there is an outcrop of this rock.

The Scotch ice-sheet flowed outward on all sides, but on the east it was met by the southward extension of the great Scandinavian ice-sheet. On the extreme north the meeting of these two ice-sheets resulted in a flow to the northwest which glaciated the Orkney Islands, while the Shetlands, much farther north, received the full impact of the Scandinavian ice alone, and are therefore glaciated from the northeast. The dividing line of the Scotch and Scandinavian ice-sheets was in the North Sea, not far from the east coast of Scotland; but farther south, at Flamborough Head and Holderness, the latter impinged on our coast, bringing with it enormous quantities of Scandinavian rocks. Many years ago Prof. Sedgwick described the cliffs of bowlder clay at Holderness as containing "an incredible number of smooth round blocks of granite, gneiss, greenstone, mica slate, etc., resembling none of the rocks of England, but resembling specimens derived from various parts of the great Scandinavian chain." These are mixed, however, with a number of British rocks from the north and west, indicating the meeting ground of the two conflicting ice-sheets. Similar blocks occur all along the coast as far as the cliffs of Cromer in Norfolk. Across the peninsula of Flamborough about two miles west of the lighthouse there is a moraine ridge containing a few Scandinavian bowlders, but mainly composed of British rocks. These latter consist of numerous carboniferous rocks from the north and northwest, together with many of Shap granite —a peculiar rock found only on Shap Fell in the eastern side of the Lake District, together with a few of Galloway granite. These facts, it will be seen, add further confirmation to the theory of great confluent ice-sheets indicated by the ice-markings upon the various groups of mountains, while it is hopelessly impossible to explain them on any theory of local glaciers, even with the aid of submergence and of floating ice.

The study of our British erratics has been assiduously pursued for many years past by a committee of the British Association; and by means of a map showing the chief facts collected up to this date, kindly furnished me by Mr. Percy F. Kendal, secretary of the committee, I am able to give a brief sketch of the more important of the phenomena, and their bearing on the extent and motion of the British ice-sheet. The general reader may be informed that great numbers of rocks are so local and so characteristic, often being confined to a very limited district or to a single mountain, that the origin of a considerable portion of the erratics can be ascertained with the greatest certainty.

Taking first the Shap granite, which has already been men-

tioned as occurring at Flamborough Head, we find that it has been carried northward as far as the Solway Frith, and eastward to the Eden Valley in great quantity and over a wide area. Thence can be traced a line of bowlders of this rock over the high plateau of Stainmoor into the valley of the Tees, and onward round the coast by Scarborough to Holderness, while a branch descends southward along the valley of the Ouse to York. Coming back to its source on Shap Fell, a train of bowlders of the same rock has been traced southward in a curving line, passing the east side of Morecambe Bay near Lancaster, and thence sparingly southeastward to near Whalley. Along the same line are found bowlders of peculiar granites from Eskdale and Buttermere, marking the line of junction of the northern ice-sheet with that which filled up the Irish Sea and pressed inward between the glaciers of Cumberland and North Wales. This is indicated by the fact that south of this line are scattered immense quantities of erratics, both from the southwest of Scotland and the Lake District, spreading over the whole of the low country as far as Bridgnorth and Wolverhampton, and eastward to the Derbyshire highlands. These same erratics are found round the north coasts of Wales and part of Anglesea, showing how the iceflows divided on either side of the mountain mass of North Wales.

The center of the great glacier sheet of North Wales appears to have been over the Arenig Mountains, whence erratics of a peculiar volcanic rock have been traced to the north and east, mingling with the last-described group; while a distinct train of these Welsh erratics stretches southeastward to the country west of Birmingham.

In the Isle of Man are found many erratics from Galloway and a few from the Lake District. But the most remarkable are those of a very peculiar rock found only on Ailsa Craig, a small island in the Frith of Clyde, and a single bowlder of a peculiar pitchstone found only in the Isle of Arran. The Ailsa Craig rock has also been found at Moel Tryfaen, on the west side of Snowdon, and more recently at Killiney, County Dublin, on the seashore.*

The case of the bowlders in the Isle of Man, which have been carried nearly eight hundred feet above their source, has already been mentioned, but there are many other examples of this phenomenon in our islands; and as they are of great importance in regard to the general theory of glacial motion a few of them may be noted here. So early as 1818 Mr. Weaver described a granite block on the top of Cronebane, a slate hill in Ireland, and several hundred feet higher than any place where similar granite was to be found *in situ*; and he also noticed several deposits of limestone

* Nature, vol. xlvii, p. 161.

gravel in places from three to four hundred feet higher than the beds of limestone rock which are from two to ten miles off. *Débris* of red sandstone is also found much higher than the parent rock. Bowlders of Shap granite, Mr. Kendal tells us, have passed over Stainmoor by tens of thousands, and in doing so have been carried about two hundred feet above their source; and the curious Permian rock, "Brockram," has been carried in the same direction no less than a thousand feet higher than its highest point of origin.* In Scandinavia there are still more striking examples, erratic blocks having been found at an elevation of forty-five hundred feet which could not possibly have come from any place higher than eighteen hundred feet.† We thus find clear and absolute demonstration of glacier ice moving up-hill and dragging with it rocks from lower levels to elevations varying from two hundred to twenty-seven hundred feet above their origin. In Switzerland we have proof of the same general fact in the terminal moraine of the northern branch of the Rhone glacier being about two hundred feet higher than the Lake of Geneva, with very much higher intervening ground. As it is universally admitted that the glacier of the Rhone did extend to beyond Soleure, all the *a priori* objections to the various cases of rocks carried much higher than their origin, in America, the British Isles, and Scandinavia, fall to the ground. We must either deny the existence of the ice-sheet in the great Swiss valley, and find some other means of accounting for the traveled blocks on the Jura between Geneva and Soleure, or admit that the lower strata of a great glacier *can* travel up-hill and over hill and valley, and that the ice-sheets of the British Isles, of Scandinavia, and of North America merely exhibit the very same characteristics as those of Switzerland, but sometimes on a larger scale. We may not be yet able to explain fully how it thus moves, or what slope of the upper surface is required in order that the bottom of the ice may move up a given ascent, but the fact of such motion can not any longer be denied.

The facts thus established render it more easy for us to accept one of the latest conclusions of British glacialists. A great submergence of a large portion of the British Isles during the Glacial period, or in the interval between successive phases of the Glacial period, has long been accepted by geologists, and maps have been often published showing the small group of islands to which our country was then reduced, the supposed subsidence being about fourteen hundred feet. The evidence for this is the occurrence, at a few spots, of glacial gravels containing marine

* Wright's Man and the Glacial Period, p. 154.

† James Geikie's Great Ice Age, second edition, p. 404.

shells in tolerable abundance, the most celebrated being at Moel Tryfaen, on the west side of Snowdon, at a height of more than thirteen hundred feet. Shell-bearing drifts have also been found near Macclesfield at a height of over eleven hundred feet, and to the east of Manchester at between five and six hundred feet elevation. Others have since been found on Gloppa, a hill near Oswestry. The fact that the shell-bearing gravels of Moel Tryfaen are nearly forty feet thick shows that, if they are due to submergence, the land must have remained stationary at that level for a considerable period of time, and there would probably be other stationary periods at lower levels. Yet nowhere in the valleys or on the hill slopes of Wales, or the Lake District, or in the English lowlands are there any of the old beaches or sea cliffs, ormarine deposits of any kind, that must have been formed during such a subsidence and which can hardly have been everywhere cleared away by subsequent glaciation. Another difficulty is that the shells of these drifts are such as could not have lived together on one spot, some being northern species, others southern, some frequenting sandy others muddy bottoms, some which live only below tidal water while others are shore species. And, lastly, they are very fragmentary, only a small percentage of entire shells being found.

In consequence of these various difficulties it was suggested by the late Mr. Belt that the great Irish Sea ice-sheet had carried up a portion of the sea-bottom imbedded in its substance, perhaps containing deposits of shells of various periods and thus explaining the intermixture of species as well as their fragmentary condition. The fact that bowlders and pebbles from Scotland, Ailsa Craig, and Cumberland have been found in the Moel Tryfaen beds almost amounts to a proof that they were so uplifted; and a recent search has shown that in the other localities where marine shells have been found in drift at great elevations similar foreign rocks occur, rendering it almost certain that the same ice-sheets which have distributed foreign erratics so widely over our country, and which in doing so *must* have passed over the sea-bottom, have in a few cases carried with them a portion of that sea-bottom, and deposited it with the erratics in the places where both are now found. A full discussion of this point, with replies to various objections, by Mr. P. F. Kendal, will be found in the volume already quoted; and he has recently adduced a fresh argument against "the great submergence" in the fact that, if it ever occurred, our lowlands must for a long time have formed the bottom of a sea two hundred fathoms deep, yet not a single shell characteristic of that depth has yet been discovered in the drift.* The cumulative

* Wright's Man and the Glacial Period, pp. 167–175. Also Geological Magazine, November, 1892, pp. 491–500.

evidence against the submergence is now almost, if not quite, conclusive.

In the brief outline now given of the facts of glacial geology bearing upon the former existence, the thickness, extent, and motion of ice-sheets, it has only been possible to treat the subject very broadly, omitting all those details and minor difficulties which can not be discussed within the limits of a popular article. My object has been to explain the nature and amount of the converging evidence demonstrating the existence of enormous ice-sheets in the Northern hemisphere, to serve as a basis for the discussion of the glacial origin of lake-basins, which will form the subject of another article.—*Fortnightly Review.*

A CENTURY OF THE TELEGRAPH IN FRANCE.

By WALTER LODIAN.

It is one hundred years ago (the 22d of March, 1792) since a young man named Claude Chappe presented himself at the bar of the Legislative Assembly. He carried there a secret vocabulary composed of nine thousand nine hundred and ninety-nine words, represented by some numbers, and destined to be transmitted by a system of visual telegraphy by means of a machine carrying the signals from station to station.

The examination of the machine was promptly confided to a committee, which reported in favor of its adoption, and a little after, the Convention voted the funds necessary to the establishment of a trial line.

It is this memorable event—the origin of the most marvelous discovery of our times—which the telegraphic people have recently *fêted* as solemnly as possible.

On this occasion it has appeared to us useful as well as interesting to retrace the history of telegraphy in France, to note briefly the successive stages and the perfecting of the telegraphs which have transformed the world.

Some essays in telegraphy were made in modern times, notably at the end of the seventeenth century, by Dr. Hooke, an English physician, who made service of an apparatus consisting of some characters of a sufficient size for being perceived at a distance, each one corresponding to a letter of the alphabet.

Under the reign of the fourteenth Bourbon clique, a *savant* (G. Amontons), who became later on member of the Academy of Sciences, took up the study of the problem of aërial telegraphy. Highly interesting was the result thereof. Fontenelle, the litera-

rian, has recounted these experiences. This was, according to him, a very ingenious thing, permitting to make known all that which one would at a great distance, in little time—for example, from Paris to Rome in three or four hours—and this even with-

THE FIRST TELEGRAPHIC APPARATUS.

out the news being given out in all the space between the two cities. This preparation, so paradoxical and so chimeric in appearance, was executed in a little stretch of country, once in presence of monseigneur and once in presence of madame. The secret consisted in disposing, in several consecutive posts, some young men who, by some long-view telescopes, having perceived cer-

tain signals of the preceding post, transmitted them to the following, and always thus in succession, and these different signals were so many letters of an alphabet of which they had not the cipher then at Paris and at Rome. The greatest distance seeable by the telescopes made the distance between the posts, of which the number was to be the least that was possible, and, as the second post made some signals to the third, as soon as they were seen made at the first, the news was found carried to Rome in almost as little time as it needed for making the signals at Paris.

The government of Louis XV did not occupy themselves with what it considered a mere plaything, and the inventor, discouraged, renounced his project. Thus was relinquished, some two hundred years ago, a project in telegraphy which was about as rapid, if not rapider, than the slow-coach message from Rome to Paris of the present day, which actually takes half a dozen hours or so for the delivery from domicile to domicile.

CHAPPE.

In 1788 Dupuis experimented in turn with an alphabetic telegraph, and Linguet, on his side, was also thus occupied about the same epoch.

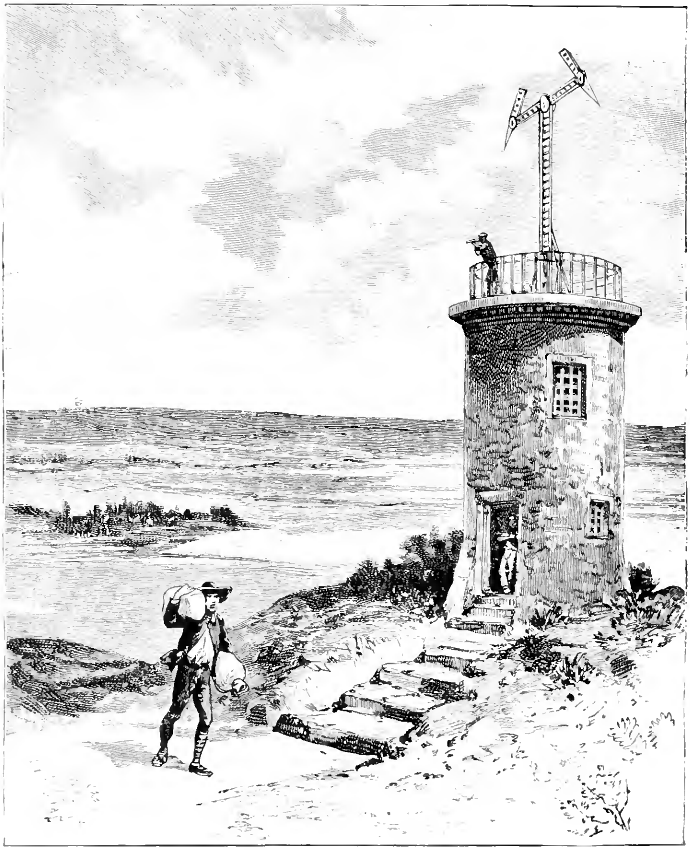
The idea was, therefore, so to say, in the air when appeared Claude Chappe, to whom the entire globe is indebted in reality for the invention of the telegraph. This is one of the events the most memorable in the history of humanity.

Claude Chappe was born at Brulon (department Sarthe) in 1763. His father gave him a classical instruction of the most approved kind. The studies of Claude, commenced at the college of Joyeuse, at Rouen, were terminated at the seminary of La Flèche; as to his four brothers, they were placed in an establishment a trifle away from this latter town, and this has caused the supposition to some of his biographers that Claude Chappe had conceived the idea of his telegraph in order to be able to communicate with his brothers. It is to-day demonstrated that this is nothing but a legend.

Chappe studied the sciences from his early youth. Physical science specially attracted him, and he published at the age of twenty years some very remarkable researches.

We have said that he submitted to the Legislative Assembly,

the 22d of March, 1792, his invention. He read his petition himself, submitting "a discovery which he thought useful to the public welfare," and presenting a facile means of communicating rapidly at great distances all that which might be the object of a correspondence. He could from them transmit the recital of a fact at night as well as at day over a space of forty



Aërial Telegraphy, 1793.

miles in less than forty-six minutes, and in a manner almost as rapid at a distance very much greater.

The Assembly accepted the tender of the machine, sent the petition to the examination of the Committee of Public Instruction, and admitted Chappe to the honors of the sitting.

Unfortunately for him, the commissioners could not attend any experiment; the ignorant populace destroyed the machine which he had constructed at Belleville. The unlucky inventor had, therefore, to demand aid and protection, with indemnity for the necessary repairs.

The Convention, which had succeeded to the Legislative Assembly in the meanwhile, resent the petition to the committee, but it was not until the 1st of April, 1793, that the deputy Romme mounted to the tribune for there to give reading of an admirable report, of which the following is a little excerpt, describing briefly the invention:

"The citizen Chappe offers an ingenious means of writing in the air by displaying some characters very trifling in number, simple as the straight lines of which they are composed, very distinct between them, of a rapid execution, and sensible at great distances. To this first part of his procedure he uses a stenography used in the diplomatic correspondences. We have made some objections to him; he has foreseen them, and has responded victoriously. He removes all the difficulties which may present themselves on the land over which is directed his line of correspondence; a sole case resists his means: this is that of a very thick fog which comes over the north, in the aqueous countries, and in winter; but outside this very rare case (which resists equally all the processes known) they will have recourse momentarily to the ordinary means. The intermediary agents employed in the procedures of the citizen Chappe can not in any manner betray the secret of his correspondence, because the stenographic value of the signals will be unknown to them. Two verbal processes of the municipality of the Sarthe attest the success of this procedure in an essay which the author has made for them, and permitting the author to advance with some assurance that with his procedure, the dispatch which reported the news of the taking of Bruxelles had been transmitted to the Convention and translated in twenty-five minutes."

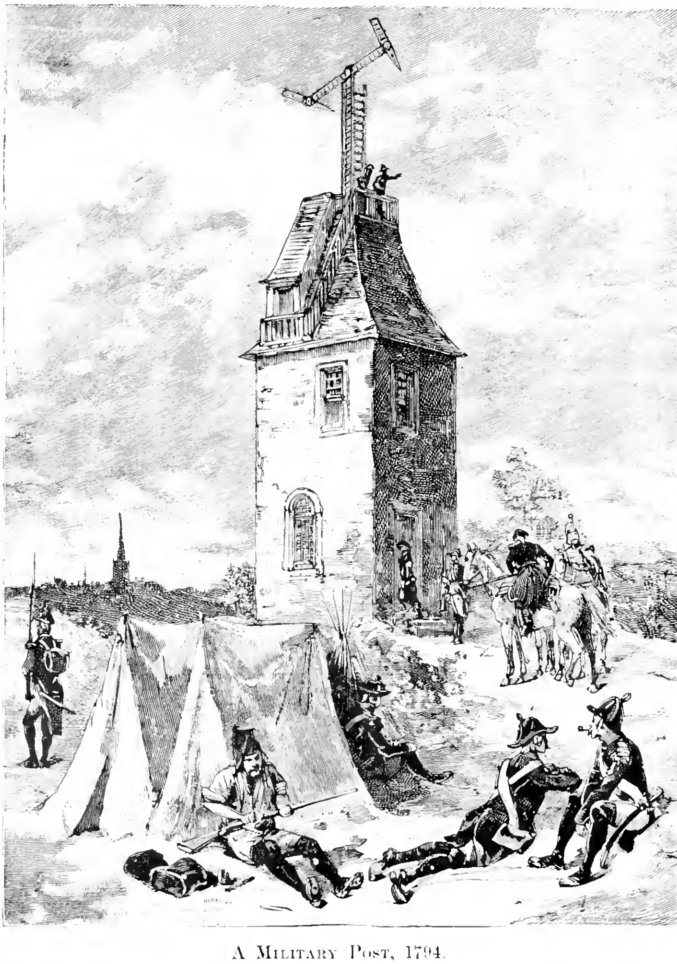
[That was, note, a hundred years ago. Bruxelles is six hours by express from Paris. The speed of transmitting over the aërial telegraph of then was much quicker than by the electric telegraph of to-day, for at present it takes much longer than half an hour—generally an hour—to remit an ordinary telegram from an office in the Belgian capital to a domicile in Paris.]

In the same sitting the National Convention rendered a decree authorizing the trials, and naming three commissaries—Lakanal, Daunou, and Arbogast. A violent opposition was soon manifested, but Lakanal sustained Chappe with all his authority, and the inventor could construct a veritable telegraphic line of thirty-five kilometres, starting from the lake St.-Fargeau, at Ménilmontant.

Finally, on the 12th of July, 1793, took place the definite trials, which were for Chappe a veritable triumph. He received the title of engineer-telegraphist, with the appointments attributed to lieutenants of artillery.

The telegraph was thus finally officially founded.

But on the 23d of January, 1805, the unfortunate Claude Chappe, tortured by a cancer in the ear, committed suicide by throwing himself in the pits of the hôtel des télégraphes, rue de Grenelle-Saint-Germain 103. He was aged only forty-two years.



A Military Post, 1794.

A stone which is still in the court of the hotel, near the central post, bears this simple inscription: "To Claude Chappe."

In 1844 the aërial network had in France a stretch of five thousand kilometres, and comprised five hundred and thirty-four stations. It was henceforth not to increase, because the first trials of the electric telegraph were taking place in Albion, and had created an immense sensation.

An order of the 23d of November, 1844, opened an extraordi-

nary credit of two hundred and forty thousand francs for making experiments. The works commenced promptly on the railroad of Paris to Rouen, and on the 18th of May, 1845, the first dispatches by the electric telegraph took place.

The first telegraphic apparatus used was the patent of Foy-Bréguet. On the 20th of November, 1850, a law was made permitting private persons to send dispatches over the wires (the state hitherto was the only party using it) after rigorous investigation of their identity. The tariff was established at three francs per dispatch of one to twenty words; over, twelve centimes per myriametre. On the 31st of December, 1851, was inaugurated the submarine cable from Calais to Dover.

The number of dispatches in 1851 was 9,014. The length of the telegraphic lines in operation attained at December 31, 1851, 2,133 kilometres.

In 1854 was created the general direction of telegraphic lines. The writing apparatus of Morse substituted the fugitive signals of the Foy-Bréguet system, and the telegraphic system went from 7,175 kilometres to 9,244 kilometres of lines.

The year 1860 was signaled by an important fact. A conditional agreement was concluded with Mr. Hughes, professor of physics at New York, the celebrated inventor of the printing apparatus, which was definitely adopted in 1861 by the French.

The decree of the 13th of August, 1864, lowered from one franc to fifty centimes the tariff on dispatches simply circulating in Paris. The happy consequences of this liberal measure surpassed the most optimistic prophecies. They resulted in the following figures, comment on which is superfluous. Number of dispatches in January, 1864, 577; in December, 1864, 11,250.

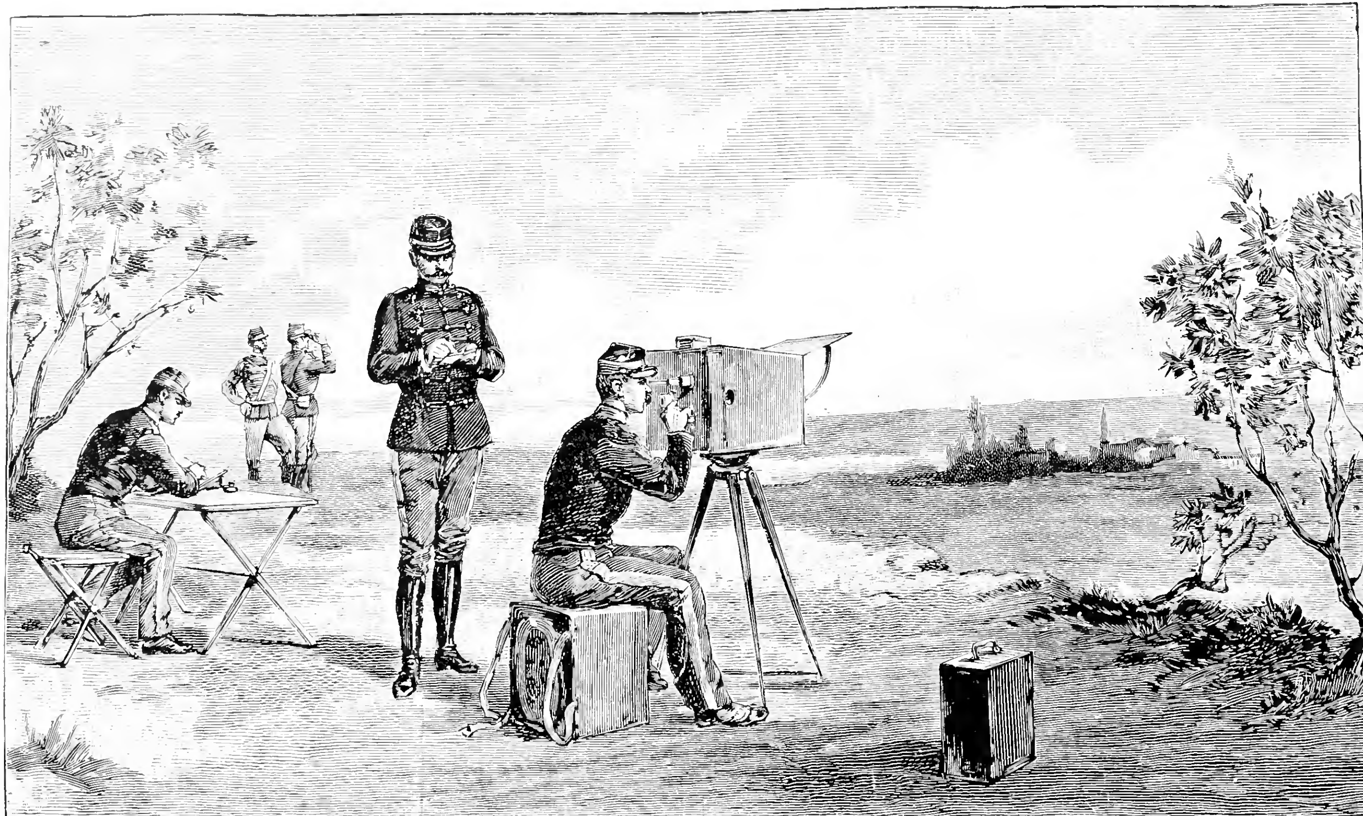
The year 1865 was marked by one of the most considerable events in telegraphy—the reunion at Paris of the first international telegraphic conference, due to the initiative of France.

Two years later the first pneumatic line appeared in Paris. With the advent of the third republic, and up to within the last years, prodigious developments have been made in telegraphy.

Military telegraphy, or optical telegraphy with the aid of the sun, has also advanced. A description of these apparatus would run into too much space. It will suffice to state that two telegraphists are necessary for managing an optical apparatus. One reads the signals aloud as he perceives them, the other writes them down. There are two classes of instruments, telescopic and "campaign."

Here are the last statistics of the telegraphic bureau in France for one year: Number of inland telegrams, 26,084,742; international, 5,318,265; total, 31,403,007.

Development of the telegraphic system: Overhead lines, 86,440



Military Optical Telegraphy.

kilometres of line, 264,980 of wire; ordinary subterranean lines, 1,719 line, 15,168 of wire; long-distance subterranean, 4,524 line, 30,237 wire; submarine, 6,004 line; private lines, 3,293 line, 6,512 wire; railroad telegraphs, 12,588 line, 106,653 wire. At end of 1890 the overhead lines alone had in all France covered some 115,000 kilometres.

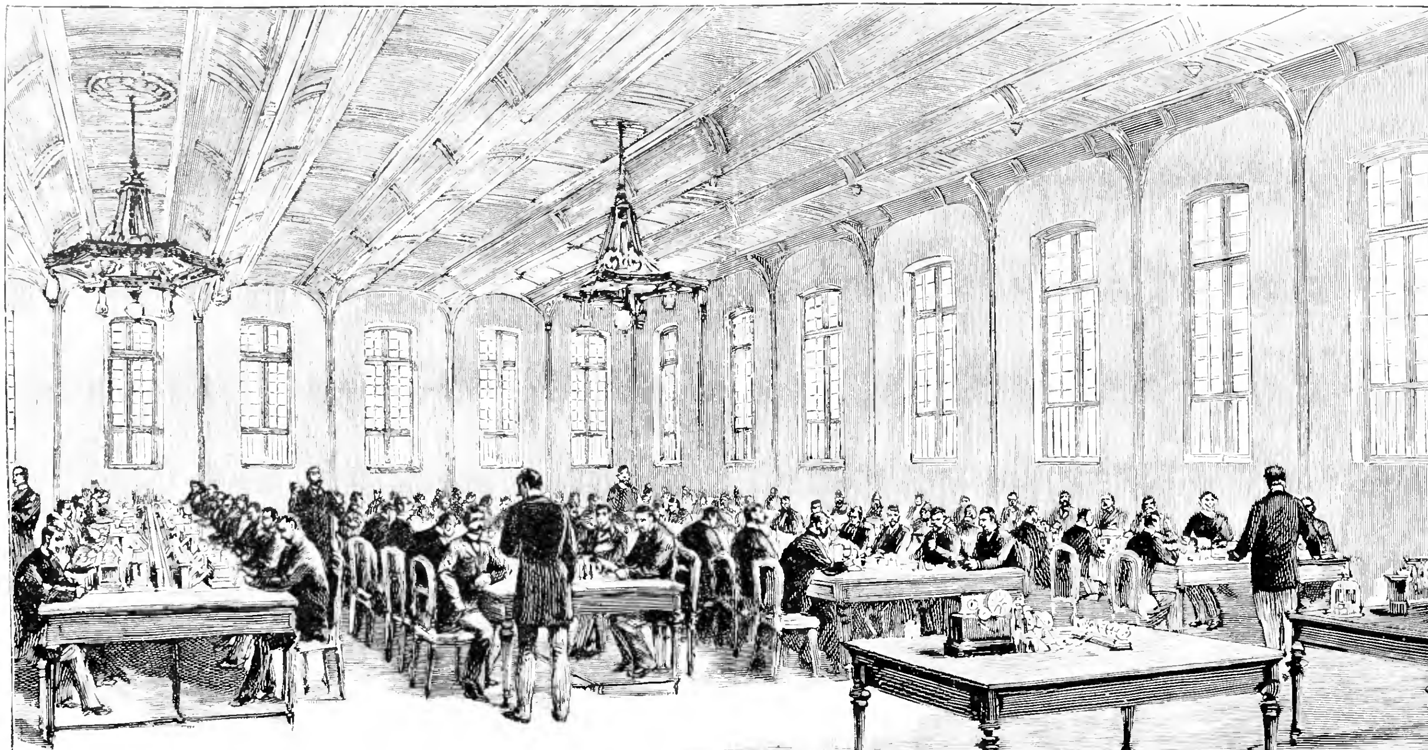
Telegraphic bureaus in France, about 9,000. They use 12,750 Morse instruments, 993 Hughes, 25 Wheatstone, 58 Baudot, 1,155 Cadran, 1 Meyer, 951 diverse; total, 15,932.

The poste central (as it is locally termed) and the telegraphic service of Paris has an exceptional importance, which is easily explained. Paris, head and heart of France, is, in effect, the center from whence all radiates and where all converges. It is at the central post of telegraphs of Paris (rue de Grenelle 103) where are managed all the telegraphic dispatches exchanged between Paris and the departments or abroad, as well as a great number of those which the different towns exchange between themselves. The poste central is exclusively a bureau of transmissions; no dispatch is disposed there directly, and it does not distribute any directly. The service is performed by about five hundred men and four hundred women. The approximate daily average of the number of telegrams expedited by the poste central is 36,250, and by all the bureaus of France 67,187.

One can conceive that a personal staff so numerous must be installed in some vast and specially furnished rooms. Two new halls have been constructed quite recently and opened for business. Their installation leaves something to be desired; the light penetrates there badly at night; they are illuminated by electricity. One of these halls is occupied by the men telegraphists, the other by the lady operators. The 362 apparati of diverse nature in service at the poste central are grouped in each one of these halls, following a methodical order based on the regional classification.

It is known that the apparati of the system Baudot are the most frequently used in telegraphy. They serve the cities of Marseilles, Havre, Lille, Bordeaux, Toulouse, Lyon, Brest, Caen, Clermont-Ferrand, and Nantes. They permit several employés to work at two, four, and even at six on the same wire, thanks to the ingenious application of the division of time realized by M. Baudot, engineer of the administration.

Two brigades share the service with the men, same as with the females, an alternating service which leaves them a little liberty. The employées (mark, the word with two final *e*'s is feminine) while at work are all dressed in black blouses to preserve their dresses from the oil stains liable to result from close contact with the apparatus. They are allowed to do, when their post is free, a little work in crocheting or in tapestry.



Operators' Room in the Great Telegraph Exchange, Paris.

On some great tables are installed the apparatus with all their accessories; each employée has allotted to her a space about ninety by ninety centimetres. Before each one there is a bar with three spikes, where they have to place separately the dispatches for abroad, the province, and Paris. In the middle of the hall is a bureau for the direction of the dispatches; two factors are attached to each section, one for unspiking the dispatches and carrying them to the direction, the other for distributing the dispatches on the posts. There is furthermore an elevator near the direction for mounting or descending the telegrams, because the men's hall, situated above, possesses all the wires connecting with the great cities of France as well as to abroad.

The basement is assuredly one of the most interesting parts of the poste-central. There are found some vaulted cellars devoted to the nine thousand elements of piles in service; in other places one will see some dynamo-electric machines, refilling pumps, etc. This is certainly not one of the least interesting features, that of seeing steam engines become the auxiliaries of telegraphy.

These machines work, on one part, the compressing pumps destined to run the Hughes apparatus and the dynamo-electric machines necessary for the production of the electric light. They work equally a dynamo-electric apparatus (an auto-regulator), which an agent of the central post, P. Picard, has had the ingenious idea to invent for replacing the piles.

Between them, the French writers, K. Fichot and H. Meyer, have managed to produce a fairly creditable account on the occasion and descriptively historical of the centenary of the foundation in France of the telegraph. The Parisians have celebrated the event, and while so fêting the centennial of the aërial telegraph they were almost at the same time, in a way, celebrating the golden jubilee of the introduction into Gaul of the electric telegraph, which was established at Paris just close on fifty years ago.

The interesting and curious paper of the Gaulois literarians above named will not be noticed in the French technical press (or, at least, it is not believed it will be); therefore an advanced translation is forwarded for the edification of English-speaking readers. In this rendering the purity of the original has been faithfully preserved as much as possible, even unto preserving some of the idiomatic peculiarities of expression of the vernacular.

It will be seen that the present summary is moderately complete,—detailing the introduction of the telegraph, some rather surprising comparisons; then the advent and progress and a few statistics of the present-day electric telegraph, description of the Paris great central bureau, etc.

AN ILLUSTRATIVE CHAPTER ON LEGAL DEVELOPMENT.

By WILLIAM W. BILLSON.

THE evidences are abundant that primitive man had no conception of ownership as distinguished from or as subsisting independently of possession. He recognized, no doubt, that one in possession of an object had a right to defend and maintain his advantageous position. If, however, the possession were lost, whether by accident, violence, or theft, the result, in the primitive judgment, was the permanent extinguishment of all relation between the object possessed and its former possessor, unless there was an immediate reseizure; somewhat as now one's claim upon wild animals, birds, or bees in his possession is forever lost by their escape, unless saved by prompt pursuit and immediate recapture. Even after the establishment of courts and the reinstatement of dispossessed persons by their authority, the relief was afforded, not upon any theory of subsisting ownership in the person dispossessed, but by way of redress for the personal grievance which he was perceived to have suffered—as now, even in the acknowledged absence of proprietary rights, we justify a person in recovering an eligible position in a street or other public place from which he has been rudely crowded by another. The legal protection of property is, historically considered, a mere extension of the protection afforded by law to the person, every wrong having been originally thought of as in the nature of a personal injustice only. The conception of ownership, instead of being the cause or historical basis of remedies for the recovery of possession, is in fact the tardy outgrowth of impressions produced upon the mind by the habitual application of those remedies as a mode of relief against injuries long regarded as purely personal.

It might be supposed that if men were ever unacquainted with the idea of ownership apart from possession it must have been in such prehistoric ages as now scarcely to admit of verification. On the contrary, no circumstance in history, perhaps, has been more prolific of legal doctrine. No finer instance can be found of that strange gift of immortality, by virtue of which the crudest of barbaric notions may live, eternal in their effects, in the polished doctrines of the most refined systems of law; no more instructive example of the evolution of the most abstruse legal refinements from the simplest germs of thought; no more impressive exhibition of the enormous inherent difficulties of legal progress, which arise from the fact that the advanced ideas of later generations, can from the nature of the case, take effect only through an adaptation of the rude and intractable forms and

proceedings inherited from a remote past. As we proceed along these lines of observation we shall incidentally fall in with interesting evidence that much of the legal complexity which we are wont to ascribe to the dark and crooked casuistry of lawyers is in the nature of an inevitable survival of customs, methods, and institutions born of the excusable mental incapacity of our foremost fathers.

So plentiful in the history of our own land are the materials for a short study of this peculiarity of early thought and its sequences that recourse will be here had to these alone, although the subject is susceptible of similar though perhaps less striking illustration from the land law of the Romans, and indeed to some extent from almost any system of law, with reference to either real or personal property.

Lawyers of a later day have experienced no little difficulty in appreciating that Britton, St. Germain, and others of our earliest legal writers spoke advisedly when they defined a freehold interest in land (which bore to our early law the relation occupied in modern law by the word ownership) as meaning the "*possession of the soil.*" Yet the accuracy of this definition at the date of its origin finds the most ample and varied attestation in our authentic legal history. The word "owner" was unknown to our early land law. That one who wrongfully dispossessed another of his land, succeeded to the estate or interest in the land, was one of the most deeply rooted doctrines of the common law from the time when the idea of an estate in lands was first conceived. The dispossessor acquired that which he could sell and transfer, and that which upon his death would descend to his heirs. On the other hand, the person dispossessed had nothing left which any one could buy or which in the event of his death his heirs could inherit. It was almost the middle of the present century before in England this ceased to be the law. The natural effect of this doctrine, as the reader will no doubt be prepared to believe, was to make the law of dispossession one of the most interesting and prolific branches of our earlier jurisprudence. It became directly and indirectly the subject matter of a surprisingly large proportion of judicial decisions, and of a correspondingly large part of the early legal commentaries, and, of course, continued to be expounded and developed in its detailed applications long after the disappearance of the mental and social conditions that gave it birth. Among the common-law applications of the rule were the following:

A wrongful usurper of the possession was considered to take in every case the entire title, or, in legal parlance, the *fee,* even though he disclaimed an intention to take more than a life estate, for it was said that he could not qualify his own wrong. If ap-

purtenant to the land seized there were easements or rights of enjoyment over other adjacent lands, the intruder by his possession of the principal estate became legally entitled to enjoy such easements. The estate of the person dispossessed was in the language of the law "turned into a right." This "right," although untransferable to any one else, could be released to the intruder, and by such release the estate of the intruder, which was tortious or wrongful, became rightful. But, although words of inheritance were generally necessary to convey more than an estate for life, no such words were necessary in a release to a dispossessor, since the fee or entire estate was already in him, though wrongfully. For the same reason a release to the intruder for a year, or even for a day, was as good as though to him and his heirs forever, since the fee, or entire title, which he already had, though wrongfully, could not, it was said, be curtailed by a deed without entry—that is, without a transfer of the possession. And upon the ground that the estate was already in the intruder, an instrument executed to him by the person ousted, although it purported to give and grant the described premises, was held to operate only as a confirmation of the estate already vested in the usurper. So, while the intruder was in possession, no action could be maintained against him for trespass, or for the value of crops harvested by him, or for other similar profits; nor could such actions be maintained even after the rightful claimant had recovered possession, except by recourse to a legal fiction (invented to avert such injustice), by which for such purposes a temporarily dispossessed person was, after recovery, construed to have been continuously in possession.

The right to dispose of lands by will was first introduced in the reign of Henry VIII by a statute which declared that "all persons having any manors, lands, or tenements may give and dispose of them by last will." In construing this statute, it was held, in harmony with the foregoing doctrines of the common law, that only those persons *had* lands who were in possession of them, and that dispossessed persons, therefore, had nothing upon which a will could operate. Such was the law in England until changed by statute in 1838. Such also had been the recognized law before the statute of Henry VIII in those counties where by local custom the power to will had previously existed.

But, although a person by being ejected from his lands lost all his estate in them, he was not without rights of redress. If he acted promptly he was entitled to recover his lost ground, and, until prohibited by the statute of Richard III, he might enlist and employ whatever forces were necessary for that purpose. The time within which this right of personal recovery, or, as it

was called in the law, right of entry, could be exercised was at first very short.

In the time of Bracton (thirteenth century) it was only four days, that being deemed sufficient time within which to arouse the neighbors and organize an invading force. The right was afterward recognized as continuing a year and a day. Still later it might be exercised during the lifetime of the intruder. Originally entry could be made only as against the intruder personally, not against one claiming under him. Afterward it could be made against the intruder's first successor, then against his second successor, still later against others still more remote, etc. It was about the time of Lord Bacon before a re-entry could be made after the lands, by death of the intruder, had passed into the possession of his heir. It was the wrongful character of the intruder's estate that was supposed to justify re-entry, and it was deemed inadmissible to treat the estate as wrongful in the hands of the heir, upon whom it had been cast by operation of law without any wrongdoing on his part.

The legal effect of a re-entry was to reinvest the ousted person with his lost estate. Originally it was no doubt necessary for him to eject the wrongdoer and resume complete control. It was soon perceived that where two persons were upon the same piece of ground, each claiming possession, he should be deemed to have the possession who had the right to it, and this principle was variously applied with salutary effects. The law was still further mitigated by considering that the effects of re-entry were attained and the estate of the intruder divested by even a temporary entrance of the ousted person upon the land under a claim of right, provided such entry was repeated at least once a year, thus keeping up publicly a continual claim to the land. And it came to be deemed sufficient as an entry if, when the ousted person could not go upon the land for fear of violence, he went as near to it as he safely could and publicly claimed it in the presence of witnesses. By these acts of re-entry and continual claim the person dispossessed could revive and keep alive his estate in the land, so as to have a conveyable and inheritable interest, although the intruder still remained in the actual possession; for, by construction of law, the entry and continual claim were treated as amounting to a recovery of the possession. The law also came to be so relaxed that where one, by the same intruder, was dispossessed of several tracts of land in one county, a re-entry upon one, in the name of all, was treated as a good entry upon all.

It is not surprising that under these circumstances there were few branches of our early law which experienced a more luxuriant growth than those that related to rights of entry, to descents that took away rights of entry, and to the making of continual claim.

If re-entry was not made within the time limited by law, the right to make it became derelict and was extinct; but there still remained the right of recovery by action at law. These actions and their procedure, and the amount of proof exacted, varied according to the length of time the intruder had remained in possession, whether and how many times the possession had been sold or transferred by or under the intruder, and so forth. Into their details it would be unprofitable to go. One who had simply a right to recover lands by action was not only destitute of anything transmissible to his heirs or to a purchaser, but had nothing which could be reached by an act of attainder. It is a noteworthy fact in this connection that our common law has never provided, either as to real or personal property, any form of action for litigating title or right of property independently of possession—a curious circumstance, unmistakably attesting that our legal remedies took form before the conception of property as distinct from possession had received practical recognition in our law.

It was, however, indirectly through its bearing upon modes of conveyance that the primitive view of property right made its deepest impression upon our law. It is manifest that when men dealt in possession only, there could not be two opinions as to the mode of effecting a sale or transfer of it. The only conceivable way was for the purchaser to take the seller's place as actual custodian; hence the universal prevalence in early societies of this mode of conveyance. Even when the theory was well advanced that the possessor of an object had an interest or estate in it, or a title to it, such interests were regarded as inherent in the possession and as inseparable from it, and therefore as passing with it and as being otherwise intransmissible. How, then, could such rights be transferred except by the manual delivery of the object? Even though there were a deed or a written or oral contract, its only function was to evidence an intent to abandon the possession in favor of another, and it was still only through the assumption of the actual possession by such other that he succeeded to the advantages resigned by the maker of the deed.

It is possible, but not certain, that during the later Anglo-Saxon period of our history this mode of conveyance had already been outgrown, and that property was then transferred by deed or charter alone, perhaps by reason of contact with Roman civilization. Be this as it may, the original mode of conveyance was, as a feature of the feudal law, so effectually resumed or continued upon the advent of the Normans that, except by means of judicial proceedings, real or feigned, the common law of England has never provided any other mode of directly transferring the entire estate in land than the solemn and public delivery of possession in the presence of the assembled neighbors, known in legal phrase

as the "livery of seisin," the word "livery" meaning delivery, and the word "seisin" meaning possession.

Although from a comparatively early day delivery was, from evidential considerations, usually accompanied by a deed, no writing was necessary until so made by the statute of Charles II; and the livery of seisin, though gradually simplified and softened into a symbolic ceremony, was indispensable to a common-law transfer of complete title until abolished by the statute of Victoria.

As already pointed out, this exclusive mode of conveyance was the natural result of the failure of early society to recognize any estate in lands which did not rest upon subsisting possession.

There are occasions upon which the possessor of lands desires to at once invest another with an estate in them which shall not commence in enjoyment or possession until a future day, as by now conveying A an estate in lands to take effect in possession when he shall become of age or marry, or upon the death of his father.

The tendency to create such future estates, representing as it does a natural desire which has always operated with more or less force since the idea of estates in land first obtained, has at times been greatly stimulated by English social and political conditions. Nor have such estates ever been deemed objectionable from the standpoint of public policy. It will be observed, however, that they are hard to reconcile with the doctrine that there can be no estate without possession, and hence no transfer of estate without transfer of possession. If, for example, in the case above supposed, possession were withheld from A, he would, in the light of that doctrine, fail to acquire any estate wh tever. If, on the other hand, possession were immediately delivered, he would get a present estate rather than a future. To what extent, then, was it possible to create future estates consistently with the ancient notion that without possession there could be no estate? This apparently simple question proved to be of almost incredible difficulty. Centuries of forensic discussion and adjudication were required for such a solution of it as the interests of society seemed to require. The answer, when complete, constituted the bulk of the marvelously complex law of remainders and executory devises.

So great was the social pressure in favor of future estates that there were doubtless points at which the reasoning was somewhat strained in order to overcome the almost insuperable resistance of the old notions respecting possession—slight deflections from the true line of logic being one of the indispensable agencies for adapting early law to the exigencies of later society. Yet the intention was to recognize future estates only so far as they were compatible with the established doctrine that an estate unsup-

ported by possession was impossible; and the question of compatibility was so closely reasoned through all its possible ramifications that there are few minor topics in any science that have elicited a more searching analysis, or which present a greater mass of subtle distinctions.

Of the body of abstruse rules thus evolved, it will be impossible within the limits of this paper to convey any adequate conception. It may be explained, however, that the door through which future estates were admitted into our law was the theory that the perpetual right of enjoyment implied from possession was an entire estate, which, by words used at the time of delivery, could, in point of time, be carved up into a number of fractions, to be successively enjoyed by different persons; and that as all these persons combined took only one entire estate, a single delivery would suffice for all, the taker of the first fraction being construed to receive the possession on behalf of all. Thus if delivery of land to A were accompanied by declaration or deed to the effect that A should have it for a term of years, then B for his life, the remainder of the estate after B's death to go to C and his heirs forever, these future estates to B and C were deemed valid, because B and C were regarded as in on the possession delivered to A.

This theory was countenanced only upon the ground that the total of the several fractional estates, thus created by a single act, was precisely equivalent to the one perpetual and uninterrupted right of enjoyment, which could be conferred upon one person by a single delivery. Any proposed future estate which could not be justified by a strict application of this theory was legally impossible. Hence, if by the terms of the delivery, or by reason of any subsequent contingency, the several fractions were not, or ceased to be, the exact equivalent of one entire estate, the future estates either never arose, or forthwith collapsed. There could, therefore, be no future estate, unless supported by a prior and present estate created by the same act; and each fractional estate must be such as to take effect in possession immediately upon the determination of the next preceding estate; otherwise it was void, and necessarily involved all succeeding estates in the ruin.

This stringent limitation arose into great importance, and indeed became the source of a large part of the law of future estates, when at a later day, upon grounds unnecessary and perhaps difficult to reproduce, it was held permissible to create future estates, doubtful or contingent as to the time when, or persons in whom, they should vest. Thus delivery might be made to A for his life, then to go for life to B's eldest son (not yet born), then forever to C and his heirs. Here it was a matter of contingency when, if ever, B would have a son. If A died before the birth of

such a son, all the subsequent estates collapsed, because, upon the ground already noticed, there could be no intermission, however short, between the successive estates. So, in the case supposed, it was possible for A, at any time, by his own act in voluntarily surrendering his own life estate, to destroy the future estates supported by it.

The great injustice and confusion of titles which flowed from this feature of the law finally led to the device of designating in cases of contingent future estates, trustees, in whom it was provided the estate should vest for the time being, in the event of the determination of a prior estate, before the contingency had happened, upon which the next succeeding estate was to take effect.

It was the *livery of seisin* which also set in motion and gave direction to that curiously complicated succession of ideas and legal devices which, during a period of more than four hundred years, made up the eventful and withal romantic history of uses, or, as they are now called, trusts—a history which at one time or another has had vital points of contact with nearly all the legal, political, religious, and domestic relations of life. That which made the use the nondescript but marvelously popular and mercurial thing that for centuries it was, was the tenacity with which the common-law courts adhered to their doctrine that, because the livery of seisin was not made to the beneficiary of a use, he took nothing which could be regarded as property, or which could be charged with the burdens or liabilities of property; that in fact "he had no more to do with the land than the merest stranger in the world"; while at the same time his every claim of control over the land was regularly enforced by courts of equity. Again, to the entanglement of the common law of possessions with the equitable law of uses, which was brought about in the middle of the sixteenth century through certain expressions in the statute of uses, and which gave rise to such obscure questions as the character of the seisin which was necessary under the statute to feed or serve uses, are directly traceable the most subtle distinctions of the law of springing and shifting uses and powers, words which, though the unprofessional reader may not fully understand, he may safely assume to stand, together with remainders, for all that was and is most abstruse and intricate in our law.

So it was the *livery of seisin* which, either directly, or indirectly through the law of uses, gave color and form to all the methods of conveyance, which through common-law devices or statutory provision were by strangely circuitous methods gradually substituted for it in the transfer of lands. The impossibility of compressing into this paper an adequate review of the developments which our subject underwent in connection with uses and convey-

ancing makes it necessary to reserve that interesting chain of events for future consideration.

That the early law took no cognizance of ownership apart from possession was strikingly exhibited in the view which it took of inheritances. The estate of a possessor in lands was palpably terminated by his death. Yet his heir acquired no estate in the lands except by entering into the possession. If the heir died before entry, the lands went, not to his heir, but to the next heir of the ancestor who died in possession. In like manner, though one had received a deed of lands, yet if he died before entering into possession, he was deemed not to have acquired any estate, and consequently left nothing which his heirs could inherit, or of which his widow could have dower. And so it was, although he had actually entered into the possession under a deed, unless he had been publicly invested by the ceremony of *livery of seisin*.

It was among the miscellaneous corollaries of the *livery of seisin* that it was impossible for a landlord to sell his interest in the land without the concurrence of his tenant. The tenant being in possession, the landlord could only make *livery of seisin* to the purchaser by arranging with the tenant to temporarily retire, so that he, the landlord, could take the possession and deliver it, after which the tenant would resume possession under the new owner. In this and a variety of other ways the *livery of seisin* entered into the law of attornment.

We have remaining space only for casual reference to some of the processes, in addition to those already mentioned, by which the old notions and customs, which have been our theme, were gradually displaced or assimilated by modern legal conceptions. The idea of possession was gradually enlarged, so that one who had been in the actual possession was deemed to continue in it until it was seized by another, even though the property were in fact vacant.

Delivery, which at first must be made on the land, was afterward permitted to be made in presence of the neighbors at any place in sight of the land, and later at public places even more remote; and delivery of one tract might be made for several tracts in the same county; but in none of these cases did the estate pass until, in pursuance of such constructive deliveries, possession had been actually taken. So it became the custom to substitute a symbolic for an actual delivery, as by delivering a turf from the land or a key of the house. And so there came a time when, if one had bought and paid for land from another, who then refused to make *livery of seisin*, courts of equity would specifically enforce the agreement by compelling the delivery.

The celebrated statute of uses, 27 Henry VIII, opened up the way for conveyances without delivery. Into these newly opened

channels the conveyancing of the kingdom largely flowed, and the *livery of seisin* dropped into comparative desuetude. By later statutes, principally of the present reign, the ceremony and many of its related rules have been finally abolished. It was never practiced to any considerable extent in this country, which was not colonized until after the statute of uses.

Although the idea that there could be no estate in land without possession was so inextricably interwoven with the doctrines of the common law that escape from its meshes was impossible except by resort to legislation, the popular conceptions upon the subject, being comparatively unhampered, underwent necessarily a much more rapid change, so that in the popular sense or judgment interests in land, independently of the possession, existed centuries before it was possible for them to receive legal recognition. Finally, even to the most technical of lawyers, the old view came to seem like scarcely more than a legal fiction. In its direct applications it has now almost disappeared from our law. Its *effects* are simply ineffaceable. The time will never be when the legal doctrines of the English-speaking race will not still present numberless peculiarities of structure inherited from this prolific old juristic root.

THE BEAVER EATER.

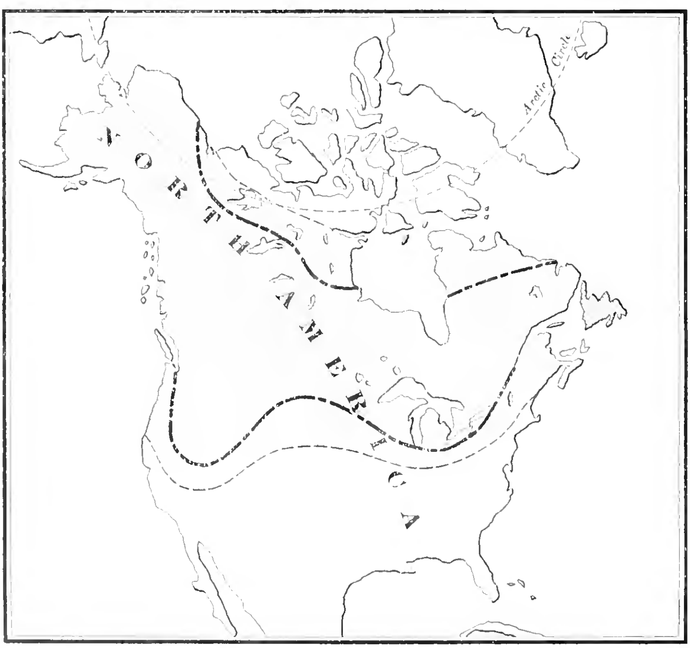
By HORACE T. MARTIN, F. Z. S., Etc.

A VOCABULARY of the Chippeway Indians in J. Long's Voyages and Travels (1791) conveys a slight knowledge of the fur trader's vernacular of just a century ago. The records offer many attractions to the naturalist, acquainting him with the curious Indian names for animals, together with their English equivalents, and exhibiting the original forms of many words familiar now only in a modified or corrupted state. In this vocabulary the Indian word *quickwahay* is translated "beaver eater," and neither of the terms being current to-day in natural history, they suggest a field for investigation.

To discover the truths which are the foundation of most fables is a task both useful and interesting, and the curious facts which underlie the fabulous history of the animal about to receive our consideration illustrate this rule in an extreme degree. If a bad name be sufficient excuse for hanging a dog, what should be the fate of that animal whose evil names outnumber his digits? Probably no animal has ever possessed a longer list of synonyms, and none could possibly possess worse. The first written accounts of our subject date back to Olaus Magnus

(1562). He attributed to it most disgusting habits and applied the supposed appropriate name of *gulo*—a "glutton." Judging the animal by its external appearances, it was classed with the *Ursidæ*, or bear family; and its gluttony made it at once conspicuous in comparison with its less voracious relatives. That the "glutton" is grossly carnivorous is a fact, but the stories of its insatiable appetite, and its reputed habits of gorging till distended like a balloon, and the consequent method of obtaining relief, are purely fabulous.

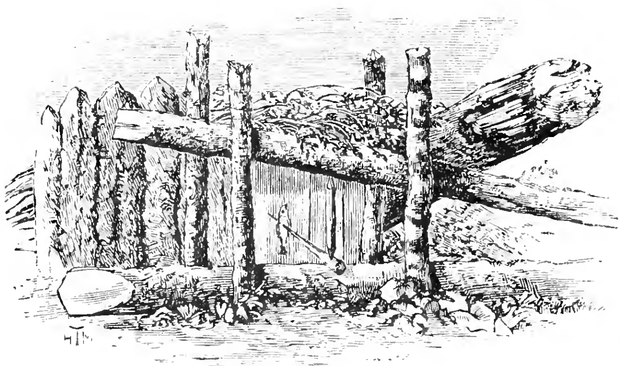
With the discovery of America a magnificent field was opened to adventurers, and "travelers' tales" found extraordinary inspiration. In 1663 Pierre Bouchet, the Governor of Three Rivers, in New France, described an animal "smaller than a fox, that climbs up trees; it is called 'child of the devil,'" and rapidly following this account came the most astounding stories. Not so repulsive but quite as improbable accomplishments were freely



The shaded portion shows the distribution of the beaver eater, while the lines — — — mark the northern and southern limits of the beaver.

recounted. The animal, it was said, killed the moose and caribou, and was more than a match for bear or wolf; but as for the timid beaver, the appellation "beaver eater" significantly suggests the fate of this defenseless rodent. It is important to remember that during almost the entire period in which these fables were so current the object of the chase was beaver pelts. Giant monopolies

controlled the traffic and inspired relentless war upon the innocent owners of these integuments. In olden times the hapless beaver was hunted for his castoreum pouches, which, Pliny says, the creature would bite off and leave to the hunter as a ransom for its life; but no compromise was possible when its coat was demanded in midwinter. Thus every beaver was the counterpart or token of value for some article of use or ornament,



A Simple Form of the "Deadfall."

brought from France to quicken the cunning and perseverance of the trapper, who would naturally exaggerate his losses, although the slaughter of beavers each fall and spring by the ever-watchful "beaver eater" must have been very appreciable. It is also worth noting that the distribution of the destroyer completely overlaid that of the destroyed, and that where the beaver has been exterminated the "beaver eater" has soon disappeared. The explanation of the other romances lies in the fact that the gourmand having already well earned unenviable notoriety, had the sins of the cougar, the lynx, the badger, and the fisher visited upon him, and many feats impossible otherwise to understand are thus accounted for.

The Indians called it *ommeethatsees* and *okeecoohawgew,* as well as *quickwahay;* and corruptions from these have given us the English forms *queequehatch, quiquihatch, quiquehatch, quickehatch,* and *quickhatch;* also the French *quincajou, corvajou, corcajue, cartajou, carcayou, karkajou,* and *carcajou,* to one or other of which forms we find references in nearly all early American writings. The trials endured by the luckless hunter, whose track was once discovered by this monster, are frequently recounted. Day after day would the hunter visit his traps, only to find the ruinous work of his four-footed enemy, who, not satisfied with robbing the occasional prize, would often, simply for the morsel of bait, completely destroy scores of traps. Hence arose the

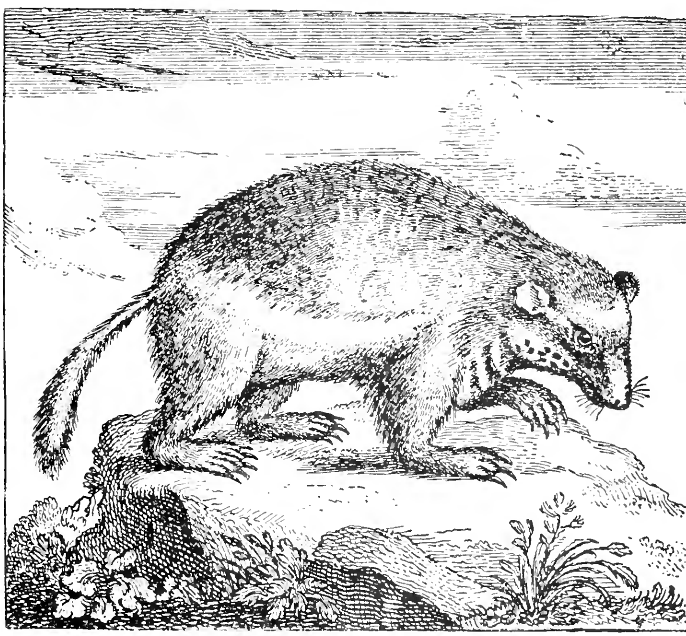
stories of the impossibility of trapping the fiend. No deadfall, snare, or spring gun ever injured this "evil one," and it does not require a vivid imagination to trace the growth of fiction, when we consider the impulsive *coureur de bois*, after the toil of setting his chain of traps and visiting them with the result above referred to, allowing himself to believe that he was verily beset by a devil, and at the camp fire, or, better still, as the honored guest of some credulous settler, unfolding and enlarging upon his experiences. These stories, however, become comprehensible when we remember that the track through the deep snow, beaten by the snowshoes of the hunter on his rounds, formed an inviting highway along which the short-limbed quadruped could freely travel, while it soon learned that a journey of a few miles meant the picking up of a substantial meal which some kind friend had carefully placed in sheltered nooks as if regardful of its wants; for the traps of those days were mostly modifications of the "deadfall," and required but limited strength and cunning to circumvent.

The creature has always been comparatively scarce, although its habitat is large; hence the stories are widespread and the scientific study of its reputed habits difficult. That the pelt is rather an uncommon article of commerce does not necessarily imply that it is of great value, although we find numerous exaggerations associated with this feature. It is stated in reports from the East that the skin was formerly held in such high repute that the angels permitted this fur alone to appear on their celestial robes, and Eastern merchants are said to have allowed an equivalent of forty or fifty dollars per skin; yet we find no market during the past one hundred and fifty years has ever quoted the pelt at more than one fourth of these figures, and to-day's quotations place five dollars as the maximum value. The demand, being as limited as the supply, accounts for this, for the skins are not more plentiful than those of the silver fox, which easily fetch one hundred dollars. The fabulous values seem to have reference to albino varieties, which must ever have been excessively rare; and though there is much beauty in the normal coloring of rich sable brown, with the paler bands along the flanks, the utility of the pelt is restricted, owing chiefly to the coarseness of the hair; and the size—only one fourth that of the black bear skin—is of a decided mediocrity, filling but few wants.

Admitting that sufficient knowledge of the animal has now been acquired to place it in its true systematic order, it is found to have no connection whatever with the bears, nor does there appear to be any affinity with the evil spirits; while the Anglo-Saxon name, implying associations with the wolf, is equally in-

correct, and this chimerical "child of the devil" becomes a respectable member of the weasel family and its largest terrestrial representative, known now to scientists as *Gulo luscus,* and popularly as the "wolverene" or "glutton."

If the wolverene does not hibernate, but spends his winter searching the woods for mere sustenance, the musteline propensity for blood is, no doubt, the impulse which makes it the great destroyer. Who has caught the weasel sleeping? Trappers say the martens run all day as well as all night; and these traits are



THE QUICKHATCH, OR WOLVERENE.

quite pronounced in the glutton, while, also, the well-known strength, pluck, and endurance of the weasels belong naturally to it.

The early name of "beaver eater" would therefore appear to be much more appropriate than either of the terms now generally used, for it has been shown that "glutton" is quite a misnomer, and the other synonym, equally incorrect, has the additional disadvantage of uncertain orthography—each of the following forms being countenanced by good authority: wolferin, wolferine, wolferene, wolvering, wolverin, wolverine, wolveren, wolverene, wolverenne, and woolverene.

ON NEW ENGLAND AND THE UPPER MISSISSIPPI BASIN IN THE GLACIAL PERIOD.*

By Prof. JAMES D. DANA.

SINCE the publication, in this Journal, of Prof. G. F. Wright's paper on the Unity of the Glacial Epoch, nearly a year since,† this subject has been much discussed in the scientific journals of the country, and with some interesting developments besides those within the purpose of the writers.

1. It has been shown that there are good working geologists on each side of the question.

2. It has been made manifest that the advocates of unity are mainly the geologists that have investigated Eastern glacial regions in the country, and especially New England, while the advocates of two Glacial epochs are chiefly those whose glacial studies have been in more western regions.

The writer, who has thus far taken no part in the recent discussion, here states that he has found in his geological explorations, which have been extensive over New England, the State of Maine excepted, no facts that require for their explanation an appeal to two Glacial epochs, and none that has even suggested the idea.

3. The presentation of arguments on the side of unity has been moderate in tone and free from dogmatism. Among geologists on the other side, great confidence in the obvious facts has given occasion to expressions almost of accomplished triumph for the two-epoch theory.

4. Among the prominent glacial investigators, one has been on both sides of the question. Having studied glacial phenomena long and faithfully in New England, Warren Upham explained the facts which he had observed on the theory of one advancing and retreating glacier, and found evidence of its terminal moraine and another halt moraine in the islands south of New England and on part of the adjoining mainland. But after some years of study in Minnesota and the neighboring States and over the region northward through Manitoba, he adopted the theory of two Glacial epochs. Returning again to New England and revising the facts there presented, he was led back to his former opinion, as he has announced in his recent papers. Since no geologist in America is better acquainted with the facts on the two sides, or more faithful and earnest in glacial investigation, these changes in his conclusions have special interest.

* From the American Journal of Science, vol. xlvi, November, 1893.

† Vol. xliv, p. 351.

5. As the above review of facts makes manifest, the division among geologists on the question, and the differences in intensity of opinion, are to a large extent geographical.

The cause of this sectional divergence in views deserves consideration. The writer has come to the conclusion that the cause is largely *meteorological:* that the geological differences in opinion are a consequence not only of differences in observed facts in the West as compared with those of the East, but back of these, in meteorological differences in the two regions during the Glacial period.

At the present time the glaciated areas of eastern and central North America differ widely in hygrometric conditions. For New England and three fourths of the State of New York the mean annual precipitation, according to Schott's maps, varies from thirty-eight to forty-two inches—a broad coast region, nearly half the breadth of New England, excepted over which it amounts in some parts to fifty inches; while for Wisconsin it varies from thirty-two to thirty-eight inches, and for the larger part of Minnesota, from twenty to thirty-two inches. North of New England, in British America east of Hudson Bay, the annual precipitation is from thirty-two to twenty inches; but to the west of this region, over Manitoba and beyond, it is twenty to ten inches.

Here is a large present difference between the eastern and western regions, affecting snowfalls as well as rainfalls.

Now, in the Glacial period, this eastern region would not only have had the same great advantage as now of proximity to the Atlantic Ocean, but also that of greater height than now. The evidence appears to be conclusive that along the Atlantic side of the continent from southern New England northward, as well as on the Pacific side, the continent stood much above its present level, and that the elevation was the culmination of that which was in progress during the closing part of the Tertiary era—as urged by Prof. Upham. However much the surface of the great medial valley of the continent was raised, it can not be reasonably questioned that the border mountain regions experienced the greater amount of elevation. Hence, with the mountain condensers on the east so much increased in altitude and extent, the differences between the eastern and interior regions as to precipitation would have been greatly augmented, to the advantage of the eastern region.

Further, the Glacial period was probably a time of greater precipitation than now, as well as of greater cold. Some have said, of greater precipitation, and not of greater cold; but the former of these two statements has general acceptance. If the surface waters of the Atlantic basin were warmer than now—owing to a rise of land along a belt from southeast to northwest through

Iceland as part of the general rise on the American and European sides—this would account for greater precipitation on the borders of the ocean, and especially over its western border, the American.

But leaving this source of increased precipitation out of consideration, it is plain that in the Glacial period the difference in amount of precipitation over the high eastern border made into a lofty ice plateau by the accumulation of snow and ice, and over the broad medial belt from Wisconsin and Minnesota northwestward, should have been much greater than it is now. Moreover, this central valley of North America would have had something of the existing disadvantage of a relatively warm summer temperature. At the present time, in July, a mean temperature of 70° Fahr. extends beyond the latitude of Lake Winnipeg even to 56° north, and this is 10° in latitude, or nearly seven hundred miles, farther north than the position of the same heat line over New England.

The advantages for ice-making of eastern over central North America were, therefore, very great, both as regards temperature and precipitation. When the conditions over the interior were sufficient to produce a small annual gain of ice, those over New England would have been making a very large annual gain. A small gain continued for many scores of centuries would make finally a great thickness of ice. But with the conditions over the interior near the critical point, a small unfavorable meteorological change, if long continued, might carry off the ice for scores or hundreds of miles from a southern limit, with proportionate floods from the melting, while the eastern border was all the time gaining in ice, or was making only a short retreat.

The actual facts correspond with these views. The distance in the upper Mississippi basin between the farthest southern limit of the ice and the line of the great moraine, or that of the so-called "second Glacial epoch," is over five hundred miles; but to the eastward it narrows through Indiana, Ohio, Pennsylvania, and New Jersey; and in New England a corresponding moraine interval can not be certainly made out, and nothing exists that could not be better explained by reference to short retreats in a single glacier.

I leave the subjects here for the consideration of geologists of the East and West. The cause appealed to explains at least why the geologists of the East and West are divided on the subject; and also why the grand display of terminal and retreat moraines characterizing the West produces there the stronger opinions and the stronger expressions of opinions; and why also a complete survey of the facts will probably lead to a general agreement in favor of a single Glacial epoch only.

THE LATE PROFESSOR TYNDALL.*

By HERBERT SPENCER.

AMONG the various penalties entailed by ill-health, a not infrequent one is the inability to pay the last honors to a valued friend; and sometimes another is the undue postponement of such tribute to his memory as remains possible. Of both these evils I have just had experience.

It was, I think, in 1852 that Prof. Tyndall gave at the Royal Institution the lecture by which he won his spurs: proving, as he then did, to Faraday himself, that he had been wrong in denying diamagnetic polarity. I was present at that lecture; and when introduced to him very shortly after it, there commenced one of those friendships which enter into the fabric of life and leave their marks. Though both had pronounced opinions about most things, and though neither had much reticence, the forty years which have elapsed since we first met witnessed no interruption of our cordial relations. Indeed, during recent years of invalid life suffered by both of us, the warmth of nature characteristic of him has had increased opportunity for manifesting itself. A letter from him, dated November 25th, inquiring my impressions concerning the climate of this place (St. Leonards), raised the hope that something more than intercourse by correspondence would follow; but before I received a response to my reply there came the news of the sad catastrophe.

I need not dwell on the more conspicuous of Prof. Tyndall's intellectual traits, for these are familiar to multitudes of readers. His copiousness of illustration, his closeness of reasoning, and his lucidity of statement, have been sufficiently emphasized by others. Here I will remark only on certain powers of thought, not quite so obvious, which have had much to do with his successes. Of these the chief is "the scientific use of the imagination." He has himself insisted upon the need for this, and his own career exemplifies it. There prevail, almost universally, very erroneous ideas concerning the nature of imagination. Superstitious peoples, whose folklore is full of tales of fairies and the like, are said to be imaginative; while nobody ascribes imagination to the inventor of a new machine. Were this conception of imagination the true one, it would imply that, whereas children and savages are largely endowed with it, and whereas it is displayed in a high degree by poets of the first order, it is deficient in those having intermediate types of mind. But, as rightly conceived, imagination is the power of mental representation, and is measured by

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the vividness and truth of this representation. So conceived, it is seen to distinguish not poets only, but men of science; for in them, too, "imagination bodies forth the forms [and actions] of things unknown." It does this in an equal, and sometimes even in a higher degree; for, strange as the assertion will seem to most, it is nevertheless true that the mathematician who discloses to us some previously unknown order of space-relations, does so by a greater effort of imagination than is implied by any poetic creation. The difference lies in the fact that, whereas the imagination of the poet is exercised upon objects of human interest and his ideas glow with emotion, the imagination of the mathematician is exercised upon things utterly remote from human interest, and which excite no emotion: the contrasted appreciations of their respective powers being due to the circumstance that whereas people at large can follow, to a greater or less extent, the imaginations of the poet, the imaginations of the mathematician lie in a field inaccessible to them, and practically non-existent.

This constructive imagination (for we are not concerned with mere reminiscent imagination), here resulting in the creations of the poet and there in the discoveries of the man of science, is the highest of human faculties. With this faculty Prof. Tyndall was largely endowed. In common with successful investigators in general, he displayed it in forming true conceptions of physical processes previously misinterpreted or uninterpreted; and, again, in conceiving modes by which the actual relations of the phenomena could be demonstrated; and, again, in devising fit appliances to this end. But to a much greater extent than usual, he displayed constructive imagination in other fields. He was an excellent expositor; and good exposition implies much constructive imagination. A pre-requisite is the forming of true ideas of the mental states of those who are to be taught; and a further pre-requisite is the imagining of methods by which, beginning with conceptions they possess, there may be built up in their minds the conceptions they do not possess. Of constructive imagination as displayed in this sphere, men at large appear to be almost devoid; as witness the absurd systems of teaching which in past times, and in large measure at present, have stupefied, and still stupefy, children by presenting abstract ideas before they have any concrete ideas from which they can be drawn. Whether as lecturer or writer, Prof. Tyndall carefully avoided this vicious practice.

In one further way was his constructive imagination exemplified. When at Queenwood College he not only took care to set forth truths in such ways and in such order that the comprehension of them developed naturally in the minds of those he taught —he did more: he practiced those minds themselves in construct-

ive imagination. He so presented his problems as to exercise their powers of investigation. He did not, like most teachers, make his pupils mere passive recipients, but made them active explorers.

As these facts imply, Prof. Tyndall's thoughts were not limited to physics and allied sciences, but passed into psychology; and though this was not one of his topics, it was a subject of interest to him. Led as he was to make excursions into the science of mind, he was led also into that indeterminate region through which this science passes into the science of being; if we can call that a science of which the issue is nescience. He was much more conscious than physicists usually are that every physical inquiry, pursued to the end, brings us down to metaphysics, and leaves us face to face with an insoluble problem. Sundry propositions which physicists include as lying within their domain do not belong to physics at all, but are concerned with our cognitions of matter and force: a fact clearly shown by the controversy at present going on about the fundamentals of dynamics. But in him the consciousness that there here exists a door which, though open, science can not pass through, if not always present, was ever ready to emerge. Not improbably his early familiarity with theological questions given him by the controversy between Catholicism and Protestantism, which occupied his mind much during youth, may have had to do with this. But whatever its cause, the fact, as proved by various spoken and written words, was a belief that the known is surrounded by an unknown, which he recognized as something more than a negation. Men of science may be divided into two classes, of which the one, well exemplified in Faraday, keeping their science and their religion absolutely separate, are untroubled by any incongruities between them; and the other of which, occupying themselves exclusively with the facts of science, never ask what implications they have. Be it trilobite or be it double-star, their thought about it is much like the thought of Peter Bell about the primrose. Tyndall did not belong to either class; and of the last I have heard him speak with implied scorn.

Being thus not simply a specialist but in considerable measure a generalist, willingly giving some attention to the organic sciences, if not largely acquainted with them, and awake to "the humanities," if not in the collegiate sense, yet in a wider sense—Tyndall was an interesting companion; beneficially interesting to those with brains in a normal state, but to me injuriously interesting, as being too exciting. Twice I had experience of this. When, after an injury received while bathing in a Swiss mountain-stream, he was laid up for some time, and, on getting back to England, remained at Folkestone, I went down to spend a few days

with him. "Do you believe in matter?" was a question which he propounded just as we were about to bid one another good-night after a day's continuous talking. Ever since a nervous breakdown in 1855, over my second book, talking has told upon me just as much as working, and has had to be kept within narrow limits; so that persistence in this kind of thing was out of the question, and I had to abridge my stay. Once more the like happened when, after the meeting of the British Association at Liverpool, we adjourned to the Lakes. Gossip, which may be carried on without much intellectual tax, formed but a small element in our conversation. There was almost unceasing discussion as we rambled along the shore of Windermere, or walked up to Rydal Mount (leaving our names in the visitors' book), or as we were being rowed along Grasmere, or when climbing Loughrigg on our way back. Tyndall's intellectual vivacity gave me no rest, and after two utterly sleepless nights I had to fly.

I do not think that on these occasions, or on any other occasion, politics formed one of our topics. Whether this abstention resulted by accident or whether from perception that we should disagree, I can not say—possibly the last. Our respective leanings may be in part inferred from our respective attitudes toward Carlyle. To me, profoundly averse to autocracy, Carlyle's political doctrines had ever been repugnant. Much as I did, and still do, admire his marvelous style and the vigor, if not the truth, of his thought—so much so that I always enjoy any writing of his, however much I disagree with it—intercourse with him soon proved impracticable. Twice or thrice, in 1851–'52, I was taken to see him by Mr. G. H. Lewes; but I soon found that the alternatives were—listening in silence to his dogmas, sometimes absurd, or getting into a hot argument with him, which ended in our glaring at one another; and as I did not like either alternative I ceased to go. With Tyndall, however, the case seems to have been different—possibly because of greater tolerance of his political creed and his advocacy of personal government. The rule of the strong hand was not, I fancy, as repellent to Tyndall as to me; and, indeed, I suspect that, had occasion offered, he would not have been reluctant to exercise such rule himself. Though his sympathies were such as made him anxious for others' welfare, they did not take the direction of anxiety for others' freedom as the means to their welfare; and hence he was, I suppose, not in pronounced antagonism with Carlyle on these matters. But divergent as our beliefs and sentiments were in earlier days, there has been in recent days mutual approximation. A conversation with him, some years since, made it manifest that personal experience had greatly shaken the faith he previously had in public administrations, and made him look with more favor on the view of State-

functions held by me. On the other hand, my faith in free institutions, originally strong (though always joined with the belief that the maintenance and success of them is a question of popular character), has in these later years been greatly decreased by the conviction that the fit character is not possessed by any people, nor is likely to be possessed for ages to come. A nation of which the legislators vote as they are bid, and of which the workers surrender their rights of selling their labor as they please, has neither the ideas nor the sentiments needed for the maintenance of liberty. Lacking them, we are on the way back to the rule of the strong hand in the shape of the bureaucratic despotism of a socialist organization, and then of the military despotism which must follow it; if, indeed, some social crash does not bring this last upon us more quickly. Had we recently compared notes, I fancy that Tyndall and I should have found ourselves differing but little in our views concerning the proximate social state, if not of the ultimate social state.

In the sketch he has recently given of our late friend, who was one of the small group known as the *x* Club, Prof. Huxley has given some account of that body. Further particulars may not unfitly be added; one of which may come better from me than from him. The impression that the club exercised influence in the scientific world (not wholly without basis, I think) was naturally produced by such knowledge as there eventually arose of its composition. For it contained four presidents of the British Association, three presidents of the Royal Society, and among its members who had not filled these highest posts there were presidents of the College of Surgeons, of the Mathematical Society, and of the Chemical Society. Out of the nine I was the only one who was fellow of no society, and had presided over nothing. I speak in the past tense, for, unhappily, the number of members is reduced to five, who are now scattered, and of these only three are in good health. For years past the difficulties in the way of meeting have been growing greater, and the club is practically dead. But the detail of most interest which Prof. Huxley has not given, concerns a certain supplementary meeting which, for many years, took place after the close of our session. This lasted from October in each year to June in the next, and toward the close of June we had a gathering in the country to which the married members brought their wives; raising the number on some occasions to fifteen. Our programme was to leave town early on Saturday afternoon, in time for a ramble or a boating excursion before dinner; to have on the Sunday a picnic in some picturesque place adjacent to our temporary quarters; and, after dinner that evening, for some to return to town, while those with less pressing engagements remained until the Monday morning. Two of our

picnics were held under Burnham Beeches, one or more on St. George's Hill, Weybridge, and another in Windsor Forest. As our spirits in those days had not been subdued by years, and as we had the added pleasure of ladies' society, these gatherings were extremely enjoyable. If Tyndall did not add to the life of our party by his wit he did by his hilarity. But my special motive for naming these rural meetings of the *x* is that I may mention a fact which, to not a few, will be surprising and perhaps instructive. We sometimes carried with us to our picnic a volume of verse, which was duly utilized after the repast. On one occasion, while we reclined under the trees of Windsor Forest, Huxley read to us Tennyson's "Œnone," and on another occasion we listened to Tyndall's reading of Mrs. Browning's poem, "Lady Geraldine's Courtship." The vast majority of people suppose that science and poetry are antagonistic. Here is a fact which may perhaps cause some of them to revise their opinions.

From the impressions of Tyndall which these facts indirectly yield, let me return to impressions more directly yielded. Though it is scarcely needful to say anything about his sincerity, yet it can not properly be passed over, since it was a leading trait in his nature. It has been conspicuous to all, alike in his acts and his words. The Belfast address to the British Association exhibited his entire thought on questions which most men of science pass over from prudential considerations. But in him there was no spirit of compromise. It never occurred to him to ask what it was politic to say, but simply to ask what was true. The like has of late years been shown in his utterances concerning political matters—shown, it may be, with too great an outspokenness. This outspokenness was displayed, also, in private, and sometimes perhaps too much displayed; but every one must have the defects of his qualities, and where absolute sincerity exists, it is certain now and then to cause an expression of a feeling or opinion not adequately restrained. But the contrast in genuineness between him and the average citizen was very conspicuous. In a community of Tyndalls (to make a wild supposition) there would be none of that flabbiness characterizing current thought and action—no throwing overboard of principles elaborated by painful experience in the past, and adoption of a hand-to-mouth policy unguided by any principle. He was not the kind of man who would have voted for a bill or a clause which he secretly believed would be injurious, out of what is euphemistically called "party loyalty," or would have endeavored to bribe each section of the electorate by *ad captandum* measures, or would have hesitated to protect life and property for fear of losing votes. What he saw right to do he would have done, regardless of proximate consequences.

The ordinary tests of generosity are very defective. As rightly

measured, generosity is great in proportion to the amount of self-denial entailed; and where ample means are possessed large gifts often entail no self-denial. Far more self-denial may be involved in the performance, on another's behalf, of some act which requires time and labor. In addition to generosity under its ordinary form, which Prof. Tyndall displayed in unusual degree, he displayed it under a less common form. He was ready to take much trouble to help friends. I have had personal experience of this. Though he had always in hand some investigation of great interest to him, and though, as I have heard him say, when he had bent his mind to a subject he could not with any facility break off and resume it again, yet, when I have sought his scientific aid—information or critical opinion—I never found the slightest reluctance to give me his undivided attention. Much more markedly, however, was this kind of generosity shown in another direction. Many men, while they are eager for appreciation, manifest little or no appreciation of others, and still less go out of their way to express it. With Tyndall it was not thus: he was eager to recognize achievement. Notably in the case of Faraday, and less notably, though still conspicuously, in many cases, he has bestowed much labor and sacrificed many weeks in setting forth others' merits. It was evidently a pleasure to him to dilate on the claims of fellow-workers.

But there was a derivative form of this generosity calling for still greater eulogy. He was not content with expressing appreciation of those whose merits were recognized, but he spent energy unsparingly in drawing public attention to those whose merits were unrecognized; and time after time, in championing the causes of such, he was regardless of the antagonisms he aroused and the evils he brought on himself. This chivalrous defense of the neglected and the ill-used has been, I think, by few, if any, so often repeated. I have myself more than once benefited by his determination, quite spontaneously shown, that justice should be done in the apportionment of credit; and I have with admiration watched like actions of his in other cases—cases in which no consideration of nationality or of creed interfered in the least with his insistance on equitable distribution of honors.

In thus undertaking to fight for those who were unfairly dealt with, he displayed in another direction that very conspicuous trait which, as displayed in his Alpine feats, has made him to many persons chiefly known—I mean courage, passing very often into daring. And here let me, in closing this sketch, indicate certain mischiefs which this trait brought upon him. Courage grows by success. The demonstrated ability to deal with dangers produces readiness to meet more dangers, and is self-justifying where the muscular power and the nerve habitually prove adequate. But the

resulting habit of mind is apt to influence conduct in other spheres, where muscular power and nerve are of no avail—is apt to cause the daring of dangers which are not to be met by strength of limb or by skill. Nature, as externally presented in precipices, ice-slopes, and crevasses, may be dared by one adequately endowed; but Nature, as internally presented in the form of physical constitution, may not be thus dared with impunity. Prompted by high motives, Tyndall tended too much to disregard the protests of his body. Over-application in Germany caused at one time absolute sleeplessness for, I think he told me, more than a week; and this, with kindred transgressions, brought on that insomnia by which his after-life was troubled, and by which his powers of work were diminished; for, as I have heard him say, a sound night's sleep was followed by marked exaltation of faculty. And then, in later life, came the daring which, by its results, brought his active career to a close. He conscientiously desired to fulfill an engagement to lecture at the Royal Institution, and was not to be deterred by fear of consequences. He gave the lecture, notwithstanding the protest which for days before his system had been making. The result was a serious illness, threatening, as he thought at one time, a fatal result; and, notwithstanding a year's furlough for the recovery of health, he was eventually obliged to resign his position. But for this defiance of Nature there might have been many more years of scientific exploration, pleasurable to himself and beneficial to others; and he might have escaped that invalid life which for a long time past he had to bear.

In his case, however, the penalties of invalid life had great mitigations—mitigations such as fall to the lot of but few. It is conceivable that the physical discomforts and mental weariness which ill-health brings may be almost compensated, if not even quite compensated, by the pleasurable emotions caused by unflagging attentions and sympathetic companionship. If this ever happens, it happened in his case. All who have known the household during these years of nursing are aware of the unmeasured kindness he has received without ceasing. I happen to have had special evidence of this devotion on the one side and gratitude on the other, which I do not think I am called upon to keep to myself, but rather to do the contrary. In a letter I received from him some half-dozen years ago, referring, among other things, to Mrs. Tyndall's self-sacrificing care of him, he wrote: "She has raised my ideal of the possibilities of human nature."

THE ORIGIN OF ART.

By M. LAZAR POPOFF.

WE are accustomed to say that Egypt is the cradle of the arts; yet archæologists have demonstrated that the earliest works of art are of epochs far anterior to the ancient Egyptian civilizations. According to these authors, these works were contemporaneous with the presence of the reindeer in the south of France, and of a time when the mammoth had not yet disappeared, and when man, ignorant of the metals, made all his instruments of stone, wood, and bone. In reality, the first works of art, particularly the first efforts at drawing, date from prehistoric times. In France they are found in caverns by the side of the fossil remains of animals now extinct, like the mammoth, or which have abandoned those regions, like the reindeer, in the shape of drawings engraved with flint points as decorations of articles of reindeer horn, such as dagger handles and clubs. Drawings have also been observed on tablets of stone, horn, or ivory derived from mammoth's teeth.

We do not intend to dwell on the rudimentary, merely outline drawings, of which these ornaments consist. We invite special attention to more perfect and more characteristic works, in which, as Carl Vogt remarks, the spirit of observation and imitation of Nature, especially of living Nature, is remarkably manifest. The figure of the mammoth attracts our notice at once. A drawing found in the cavern of *La Magdelaine*, in the Dordogne, engraved on a tablet of mammoth bone, is marked by the strikingly clumsy attitude of the unwieldy body of the animal, by its long hair, the form of its lofty skull with concave front, and its enormous recurved tusks. All these features, characteristic of this extinct type of pachyderm, have been reproduced by the designer with a really artistic accuracy. The mammoth was already rare in Europe when this primitive artist lived; and that, perhaps, is the reason why only two among the numerous drawings found in the caverns of France are of that animal.* The second of these drawings, which was found in *La Lozère*, is a mammoth's head sculptured on a club.

The figures of the chamois, the bear, and the ox occur more frequently; but those of the reindeer are most numerous. Some are engraved on plates of bone, others as ornaments of various articles. Sometimes groups of animals are represented; or, on the other hand, only parts of them are given, and we see simply the head, or the head and bust.

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* Similar decorations in outline have been found in Belgian caverns, and are referred by Dupont to the age of the mammoth.

The large majority of these drawings are no better executed than those which school children make on walls. The figures of the reindeer, however, are superior, by the remarkable care with which the characteristic lines of the animal are traced, and also, in rare specimens, by the addition of shadows. The drawings of the chamois, the bear, and the ox are likewise often strikingly exact and of real value.

Besides these drawings of mammals, several representations of fishes, exact but very uniform, have been found in caverns in France. As a whole, as Broca remarks, all these relics of primitive art demonstrate that the men of this prehistoric period carefully observed the forms and attitudes of animals, and were capable of representing them exactly and elegantly, attesting a real artistic sense.

No such skill has been observed with reference to the representation of the human figure; and designs in which it appears are extremely rare. Of two of them, one represents a man naked, armed with a club, and surrounded by animals; and the second, a fishing scene, in which a man is lancing a harpoon at some marine animal—a fish, according to Broca; a whale, according to others. In this piece we are most interested in the man. The drawing, as a whole, is puerile and deformed, and the proportions are surprisingly violated. The specimen is not an exception, for the examination of all the drawings of this kind proves that the men of those times, while very skillful in the representation of animals, especially of those which were important to them, were very poor delineators of the human figure.

Another not less characteristic point is the complete absence of drawings of plants. No representation of a tree, or bush, or even of a flower is found, unless we regard as of that character the three little rosettes engraved on a handle of reindeer horn, which some authors think is the figure of a composite flower. Such undoubted exclusiveness on the part of the inhabitants of the caves was evidently not accidental, for chance explains nothing; and we can not admit, with Carl Vogt, that primitive drawing originated in a general tendency of man to the imitation of living Nature. We think the object of these artistic productions was of a quite different character, and that they were originally designed, not for ornament or for pure and simple imitation of Nature, but to secure an instrument for use in the struggle with Nature.

We remark, first, that there is nothing to prove that the men of that epoch were mentally superior to modern savages; and, if we observe these, we shall ascertain that their drawings have usually a very different significance from what they have among civilized peoples, and nothing in common with decoration and æsthetics in general. Numerous facts prove that human thought

in the lower stages of its development distinguishes poorly between subjective representations and objective results, and that both give rise to the same ideas. For instance, a savage seeing one of his family in a dream can not imagine that the image is independent of the organic substance of the personage in question; and he will see the same relation between the two as between a body and its image reflected from the surface of the water. Thus the Basutos think that if the shadow of a man is projected upon the water the crocodiles will obtain possession of the man. A similar identification may be pushed to the point that some tribes are known which use the same word to designate the soul, the image, and the shadow. This is the essential fact to be taken into consideration in order to regard primitive design in its real meaning, and to restore the conditions of the medium in which it originated. If we suppose such a material relation between the image and the object as there is between the shadow and the object, it becomes evident that the savage should deport himself in the same way toward the image, the shadow, and the object. From his point of view the image and the object it represents are in close relation, and in acting upon the one he would be acting in the same way upon the other. By virtue of this way of thinking the savage is convinced that harm done to the image passes to the object, or that in acting upon the copy we attack the original.

Proofs are numerous to demonstrate the importance which savages attribute to this mode of action on the original. Waitz tells, following Denghame, that it was dangerous in a certain tribe of West Africa to paint the portraits of natives, because they were afraid that a part of their soul would pass, by some necromancy, into the image. Sir John Lubbock notices the fear of their portrait entertained by savages—and the more like the portrait, the greater the danger to the original was supposed to be. Dr. Kane got rid of the Indians one day when they were making themselves troublesome to him by beginning to paint their portraits. Catlin relates an incident, at the same time sad and comic, of his drawing the profile of a chief named Matochiga, when the Indians around him seemed all at once very much moved. "Why did you not draw the other half of his face?" they asked; "Matochiga was never ashamed to look a white man in the face." Matochiga did not appear to have taken offense till then, when one of the Indians came up to him and, laughing, said, "The Englishman knows very well that you are only half a man, and he has only drawn half of your face because the other is worth nothing." A fatal quarrel followed this expression, and Matochiga was killed by a bullet which struck him on the side of the face that had not been drawn.

Charlevoix says that the Illinois and other Indian tribes made

little figures representing persons whose lives they wished to curtail, and stabbed them in the place of the heart. A custom still exists in Borneo of making a figure in wax of an enemy whom one desires to bewitch and melting it before the fire. They say that the person designated will waste away as his image disappears. Peruvian sorcerers proceed in the same way, except that their figures are made of rags. In the East Indies, according to Dubois, they knead with hair or bits of skin, earth collected in some muddy place, of which they make a figure, on the breast of which they write the name of an enemy; then stab the figure with needles, or otherwise mutilate it—always in the belief that similar injuries will be inflicted upon the person represented.

Vestiges of this primitive superstition are furthermore found among civilized peoples; for, as Grimm relates, Jews were accused, in the eleventh century, in Europe, of having slain Bishop Ebergard by the aid of witchcraft of this kind. These Jews had each a figure of wax representing the bishop, had bribed a priest to baptize it, and had then thrown it in the fire. The wax had hardly melted when the bishop was struck with mortal illness.

The famous adventurer Jacob, chief of the Pastoureaux, who lived in the thirteenth century, believed seriously, as he says in his Demonology, that the devil taught men the art of making images of wax and clay, the destruction of which involved the death of the persons whom they represented. In the time of Catherine de Medicis it was a custom to make such figurines of wax and to melt them over a slow fire, or stab them with needles, in order to make their enemies suffer. The operation was called *envoûtement* (or spell-binding).

We shall not be done unless we cite all the facts that prove that in the mind of the primitive man it is enough to possess any object—a piece of a coat, hair, a bit of a nail—that has belonged to a person to have power to act on him and do him harm. Faith in the efficiency of this means is so strong among backward peoples that persons who have any reason to suspect others hide their clothes in order that no part of them may be stolen. Others, when they cut their hair or nails, put the cut parts on the roof of their house or bury them. So peasants in some countries do with extracted teeth. We add, to complete our picture, that writing is regarded by the savage as endowed with the same magic force as drawing—a fact we may easily comprehend if we recollect that picture-writing preceded writing with letters or any conventional signs, and is still practiced among some savage tribes. In these picture-writings the subjection of a man or an animal to bad luck is indicated by an arrow drawn from the mouth to the heart. A sign of that kind is supposed to be equivalent to a real taking possession of the animal or the person represented.

It is doubtful whether we could give more evident proofs of the entirely special significance attributed by the savage to drawing, regarded by him as an instrument of power over another. While the examples we have cited relate particularly to man, it is logical to assume that the same process—that is, the figurative representation of animals—plays a like part in the struggle of the savage against his natural enemies. There exist other facts that confirm this hypothesis.

According to Mr. Tanner, the North American Indians, to assure success in their hunts, made rude drawings of the animals they pursue, with arrows sticking through the place of the heart, believing that they will by this means obtain power to cause the game they seek to fall into their hands. The Australians, according to an observer quoted by Tylor, make a figure of the kangaroo of grass in order to become the masters of the real kangaroos in the bush. When an Algonkin Indian wanted to slay an animal, he made a grass figure of it and hung it up in his lodge. Then, having named it several times, he shot an arrow at the image. If he hit it, it was a sign that he would kill the animal on the morrow.

In the same way, if the hunter, after he had touched the wand of a wizard with his arrow, strikes the track of an animal with the same arrow, the animal will be stopped in its flight and held till the hunter can catch up with it. The same result, according to the aborigines, can be easily secured by drawing the figure of the animal on a piece of wood, and praying to the image for success in the hunt.

Here, then, we have, in substance, the origin of the part played by drawing. An Indian song expresses this part admirably in the words, "My picture makes a god of me," and it is really doubtful whether faith in the powerful significance of the art of drawing as an instrument by the aid of which primitive man could obtain a supernatural power over his enemy or his game could be more powerfully expressed.

If we now consider the works of the cave men in the light of these facts, we shall recognize that the object that inspired them had really few points in common with the sense of beauty or the tendency to imitation; and it is clear that if there existed in the mind of primitive man a material relation between a being and its shadow or its image, that man would believe that the same relation was preserved between that being and its image transferred to any object. The purpose sought was to possess one's self of the shadow of the desired object, and the only way of doing that was to fix the silhouette of the shadow on some article. This, in our opinion, was the primary purpose of drawing, and consequently of painting.

It is noteworthy that all works of this kind appertaining to the embryonal period of the arts of design display the want of proportionality, the absence of symmetry characteristic of silhouettes of shadows. The uniform impression given by these drawings is that they refer, not to the objects themselves, but to their shadows. It is likewise interesting to remark that some contemporaneous savages—some Australians, for example—are still incapable of grasping the meaning of the most perfectly faithful images, while they readily understand a rude, ill-proportioned drawing. Thus, to give them the idea of a man, he must be drawn with a greatly enlarged head—a detail, the spirit of which is paralleled upon a drawing found in a cavern in France, and representing a fisherman. He has a very small body, but his hand, armed with an enormous harpoon, is the hand of a giant.

In his struggle with surrounding Nature—a struggle of which it is almost impossible for us to conceive an exact idea—the first need of primitive man was to possess some means of giving him confidence in victory. In going to the hunt he took with him, as the North American Indian does, and as do under another form some of the gamblers in our most civilized circles, the fetich that was to assure his success—that is, the image of the animal he wanted to kill. In engraving on the handle of his dagger the likeness of a reindeer or other animal, he was not thinking of decorating his weapon, but only of bringing some magic power to bear upon his prey; and it was precisely faith in that mysterious force, by giving him boldness, energy, and security of movement, that would procure him success. Confidence acts thus in everything.

Like the modern savage, the man of the caves believed that the greater the resemblance between the animal and its likeness, the greater was the chance of acting on the animal. Hence the care taken in the pictured reproduction of animals particularly sought for, and against which his struggle was the most earnest; hence those perfect drawings of the reindeer, that magnificent game of our ancestors. Very different are the characteristics of the drawings of human forms. To account for these differences, it must be considered that all the archæological data relative to the epoch of the reindeer are unanimous in attesting that the man of that age was of a peaceful character.

While, then, we are justified in believing that the men of the caverns very rarely raised their hands against one another, it is none the less certain that they led a bitter and truceless struggle against animals. They therefore rarely had occasion to practice the drawing of the human figure; whence the great imperfections of the figures of that kind as compared with the figures of animals.

It may be remarked, with reference to plant forms, that the boreal flora of that epoch, not being at all menacing, could furnish little food for superstition, and no drawings of plants are found in the caves.

On the whole, the condition of the art of design with primitive man appears to be in complete harmony with the meaning we have attributed to design itself—it being regarded as inspired by the belief in the existence of a material relation between a being and its image, and in the possibility of acting on the object by means of the picture.

Consequently, the principle of painting is not to be found in a natural tendency of primitive man to the artificial imitation of living Nature, but seems to be derived from the wish to subject that Nature to its wants and to subdue it.

By progressive improvements, the art of drawing has gradually lost its primitive significance and original meaning till it has become what it is now. It does not differ, however, much from what it was originally; for, while primitive man fancied he could reach the living being in its image, it is still life that living man seeks to-day in works of art.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

SKETCH OF L. D. VON SCHWEINITZ.

DURING colonial times in America, and even down into the present century, science advanced over a much obstructed path. Not having then attained to its present power and esteem, there were but few of its votaries whose whole time and best energies it could command. The explorations by which the animals, plants, and minerals of the vast Western continent were made known to science were accomplished in large part by naturalists who either followed some other vocation as a means of livelihood, or were mainly occupied by some other career to which they felt more strongly bound. Franklin was a printer and later a statesman, being an electrician only at odd times; John Bartram was a farmer; Mitchell, Hosack, and Barton were physicians; while Muhlenberg and the subject of this article were clergymen.

Lewis David von Schweinitz was born, February 13, 1780, at Bethlehem, Pa., then a Moravian Church settlement which had been founded by his family in 1741. His father, Baron Hans Christian Alexander von Schweinitz, came from an ancient and distinguished family residing on the ancestral estate called Leubla, in the present limits of Saxony. That he was a man of stable

character may be inferred from the fact that he performed the responsible duties of a treasurer general for the Moravian Church in America. The mother of Lewis was Dorothea Elizabeth, daughter of Baron (afterward Bishop) John de Watteville, and Benigna, daughter of Lewis Nicholas, Count Zinzendorf. It was to Zinzendorf and Watteville that the renewal and resuscitation of the ancient church of the *Unitas Fratrum*, or Moravian Brethren, in the eighteenth century was mainly due. In 1722 two families of the Brethren crossed the frontier of Moravia by night and made their way to the estate of Count Zinzendorf in Saxony. Here they were joined by others, and in a few years the town of Herrnhut was built by the colonists. Zinzendorf took an interest in this settlement from the start, became a bishop in the church, and devoted his life to its service. The efforts of the Brethren were early turned toward foreign missions, and it was in furtherance of mission work that Zinzendorf and Watteville came to America and founded the first Moravian settlements in this country.

Being so closely connected with the re-founders of an ancient denomination, the parents of Lewis naturally looked forward to his becoming an able promoter of the interests of their church. He was their eldest son, of a decidedly intellectual temperament and an enthusiastic disposition, and when in early boyhood he developed the habit of addressing short speeches and little sermons to the family circle, his future seemed to be definitely marked out.

When a little more than seven years old, Lewis was placed in the academy of the Moravian community at Nazareth Hall, where he remained eleven years. Young Lewis received his first impulse toward scientific study when on a visit to this school with his grandfather, Bishop de Watteville, before he entered it as a pupil. Seeing a specimen of the *Lichen digitatus* lying on a table, the child examined it with interest, and was told its name and something about its physiology. From that moment he was wont to date his interest in the vegetable kingdom. After entering the school he received some instruction in the elements of botany. A partial flora of Nazareth and vicinity, made while he was at this institution, which remained among his manuscripts at his death, is evidence that this study took immediate hold upon the mind of the youth. During his school days his powers of language and his vein of satirical humor were occasionally manifested in poetical effusions. While still a pupil and not yet eighteen years of age he assisted in teaching some of the younger classes. Lewis had three brothers, none of whom ever turned to scientific pursuits, and two sisters.

In 1798 Hans von Schweinitz was called to Germany and took

his family with him. Lewis was removed from the Nazareth seminary and after the family reached Germany was entered as a student in the theological institution at Niesky, in what was then known as the province of Lusatia, in Silesia. Here he made the acquaintance of Prof. J. B. de Albertini, who became his fast friend and his fellow-worker in botanical investigations. After completing his course as a student he became a teacher in the academy. His leisure at Niesky was occupied in the pursuit of his favorite science, in general reading and study, and in writing for the literary journals of the time. In his Memoir of von Schweinitz, read before the Academy of Natural Sciences of Philadelphia, Walter R. Johnson says of his literary activity at this time: "Scarcely any important topic in the wide field of science escaped his notice, and especially did the constitution and management of the affairs of his social and religious fraternity call forth from his pen many able and spirited articles."

The first published botanical work of von Schweinitz appeared in 1805, when he was twenty-five years of age. From the beginning of his residence at Niesky he had given especial attention to the fungi, previously little studied. The association with Albertini had continued and the discoveries of the two friends in this field had been so many as to warrant the publication of a volume of about four hundred pages on the fungi of Lusatia embodying the results of their united efforts. It was written in Latin, as was still the custom for scientific works in Europe, and the twelve plates, containing figures of ninety-three new species, with which it was illustrated, were drawn and engraved by von Schweinitz's own hands. In this work the authors creditably refrained from the then too common practice of giving new names to the already known plants included in their descriptions. They were convinced that natural history had been grievously burdened by the accumulation and confusion of synonyms, many of which promoted no other purpose than an unworthy ambition.

Soon after this Mr. von Schweinitz began to preach, and in 1807 was called to the Moravian settlement at Gnadenberg, not far from Niesky. "Considered as literary performances," says Johnson, in the memoir already cited, "his sermons were characterized by the utmost simplicity, both in style and delivery, and were addressed more to the heart than to the head. His discourses were invariably practical, not argumentative—experimental, not speculative." It was now the time of Napoleon's continental wars, and troops were quartered at Gnadenberg. The inhabitants found the presence of the soldiery irksome, but the happy disposition and winning deportment of the young pastor had much influence in preventing collisions. The next year he was invited to Gnadau, in Saxony, where he remained four

years, performing the duties of his clerical office and teaching the boys of the community who were destined for learned professions.

In 1812 Mr. von Schweinitz, being then thirty-two years of age, was appointed general agent of the Moravian Church in the southern United States. Before starting for this country he married, at Niesky, Louiza Amelia Le Doux, who belonged to a French family residing at Stettin. The continental system of Napoleon rendering direct communication with the United States extremely hazardous, Mr. von Schweinitz and his wife were compelled to go through Denmark to Sweden and embark there. The trouble of making this roundabout journey was, as it chanced, not without its compensation. The travelers were obliged to make a stay of some length at Kiel, in Holstein, during which von Schweinitz formed an enjoyable acquaintance with several of the professors in the university there. His attainments, moreover, so impressed the authorities of this seat of learning that they conferred upon him the honorary degree of Doctor of Philosophy. When, at length, the voyage was begun the United States had declared war with England and the sea swarmed with privateers. The passage abounded with thrilling adventures and providential escapes. While still in European waters the vessel fell in with a French privateer and narrowly avoided capture by taking refuge under the guns of a Danish fort. A fierce cannonade between the Danes and the Frenchman followed, many of the balls passing over and through the ship. Later it was actually captured by a British frigate, but escaped in the darkness and fog of a stormy night. Much tempestuous weather was met with, and the climax came in a terrible storm which dismasted the vessel. Nevertheless, it finally entered port in safety, being the only one of fifteen or twenty American vessels sailing from Sweden on the same day that ever reached America.

The principal church settlement of the district to which von Schweinitz had been assigned was at Salem, N. C., and there he took up his residence. Although not a native of North Carolina, he had a strong predilection for that State, having often heard his father and grandfather speak of their visits to its early settlements. His official duties were very arduous. He was a member of the Governing Board of the Moravian Churches in North Carolina, a trustee of the Salem Female Academy, the administrator of the very large landed estates owned by the church in the State, and he frequently preached in Salem and other places. Yet he found time to continue his botanical researches, which he could now carry on in a dominion, scientifically speaking, all his own. On one of his exploring trips he discovered among the Sauraton Mountains, in Stokes County, a most beautiful waterfall, which still bears his name. Among his scientific correspondents at

this time were Dr. Reichenbach, of Dresden; Kunze, of Leipsic; Major Le Conte, United States Army; Blumenbach, of Göttingen; Elliott, of South Carolina; Schwaegrichen, of Leipsic; and Hooker, of England. The first fruit of his botanical work in the South was a synopsis of the fungi of North Carolina, written in Latin, which was given to the world in 1818 through the Society of Naturalists at Leipsic, under the editorial care of Dr. D. F. Schwaegrichen. Among the one thousand three hundred and seventy-three species described in this synopsis, there are three hundred and fifteen that were new to science. In the same year his duties required him to attend a synod of his religious brethren at Herrnhut. On his way he visited England, France, and Holland, and established correspondences which were of great value to him after he returned to America and began the formation of a regular herbarium. In 1821 von Schweinitz published at Raleigh, N. C., a pamphlet containing descriptions of seventy-six species of *Hepaticæ* (liverworts), among them being nine discovered by him. In the same year he contributed to the American Journal of Science, then in its fifth volume, a Monograph on the Genus *Viola*, in which five new species were described. This was a valuable paper, and was often cited by European botanists. In it he made the interesting statement that among the thirty species of violets then known in America there was not one exactly like any of the twenty European species.

During his residence at Salem, von Schweinitz had been offered the presidency of the University of North Carolina. The acceptance of this honorable position would have necessitated giving up his service in the Moravian Church, and so, feeling that the Brethren had the best claim upon his energies, he declined it. At the beginning of the year 1822 he removed to Pennsylvania, and took up his residence in his native village of Bethlehem. Here he undertook the charge of the Moravian girls' seminary at that place, and the secular office of general agent for the Brethren was retained. His botanical studies were not suffered to languish. "The beautiful slopes and valleys about Bethlehem and Nazareth," says Johnson, "the romantic banks of the Delaware, and the precipitous rocks of the Lehigh, all yielded up to him a tribute of their hitherto unexplored treasures. The high estimation set upon his works by men of science had procured his election as an honorary member in several societies devoted to natural history, both in Europe and America. His correspondence increased, and the formation of his herbarium advanced with great rapidity." About this time Major Long's expedition to the sources of the St. Peter's River, in the Northwest Territory, returned. It had been arranged that the plants collected on this trip by Thomas

Say should be described by Nuttall. The work was begun by this naturalist, but he was obliged to go to Europe, and was prevented from returning in season to do any more. The plants were accordingly put in the hands of von Schweinitz, who described them most acceptably.

Toward the end of 1823 the then well-known botanist communicated to the Lyceum of Natural History (now the Academy of Natural Sciences), of New York, a key or analytical table for determining the American species of *Carex*—the largest genus of the sedges. This production, though small in bulk, could result only from ample knowledge and exact discrimination. In 1824 the American Journal of Science published a short paper by him on the rarer plants of Easton, Pa. There was another synod at Herrnhut this year which it was necessary for him to attend, and, having a Monograph of the North American *Carices* about completed, he put the manuscript, together with a large collection of specimens, into the hands of Dr. Torrey, in order that the monograph might be communicated to the Lyceum of Natural History in his absence. He gave full liberty for making any additions or alterations warranted by Dr. Torrey's later discoveries. When he found, on returning, that his editor had made important additions to the number of species described, von Schweinitz, with characteristic conscientiousness, requested that the paper should be published as their joint production, saying that "the judicious and elaborate amendments he has proposed, and the mass of new and valuable matter he has added, entitle Dr. Torrey to a participation in the authorship of the work." The whole number of species described was one hundred and thirteen, of which six were new. This and the analytical table of the *Carices* were both printed in the first volume of the Annals of the Lyceum. In his absence a paper in which he described fifteen new American species of *Sphæriæ*, one of the largest genera of fungi, was communicated to the Academy of Natural Sciences of Philadelphia, and appeared in vol. v of its Journal.

Von Schweinitz was absent till near the end of 1825. After his return he resumed his labors as general agent for the Brethren; the charge of the school, however, had been given up some time before. The great work to which he now devoted his attention was a Synopsis of North American Fungi. He had intended this for publication in one of the European journals, but was induced to present it, in 1831, to the American Philosophical Society of Philadelphia. In this work three thousand and ninety-eight species, belonging to two hundred and forty-six genera, were described, of which twelve hundred and three species and seven genera had been discovered by the author. If to these discoveries we add those made by von Schweinitz in other orders of

plants, we have a total of nearly fourteen hundred new species added to botanic science by the talents and industry of a single observer. The whole number of species known at his death was estimated at sixty thousand.

Until he was about fifty years of age his health had been excellent. But the various and increasing cares of his official position finally had their effect. The sedentary work involved in writing a dissertation on the affairs of his community, which prevented for a time his usual out-of-door exercise, was the immediate cause of a severe cough and other alarming symptoms of decline. His spirits, which had been uniformly cheerful, became depressed. A journey to the West to establish a branch community of the United Brethren in Indiana was temporarily beneficial, but his system was undermined and the progress of disease could not be stayed. On February 8, 1834, came the end of what his memoirist calls "a life of various, constant, and unobtrusive usefulness."

A widow and four sons survived him. All the sons entered the Moravian ministry. The eldest, Emil Adolphus de Schweinitz, was born in Salem, N. C., in 1816. He filled various ecclesiastical offices in Pennsylvania and North Carolina, was made a bishop in 1874, and died in 1879. The second son, Robert, was born in Salem, in 1819. He has filled various charges and was for many years President of the Executive Board of the American Moravian Church. Since his retirement from the active ministry he has been general treasurer of the Church and of its Foreign Mission Department. The third son, Edmund Alexander, was born in Bethlehem in 1825, and died there in 1887. He also became a bishop, and was the author of several books on the history and polity of the *Unitas Fratrum*. In 1856 he established a weekly journal for the Moravians in America, which he edited for ten years. Bernard, the youngest son, was born at Bethlehem, in 1828, and died at the age of twenty-six years, being at the time in charge of a church on Staten Island. During the latter years of the father's life he used *de* in place of *von* in his name, and the sons have always used the new form.

Von Schweinitz was of high stature, erect carriage, and robust habit. The portrait accompanying this sketch is a copy of a miniature painted some years before his death, and consequently represents him in the prime of life. He had an unusually amiable and attractive disposition, which made him a general favorite with high and low. His conversational powers were of a high order, and contributed much to an ease of intercourse which was an important factor of his usefulness. Humor, anecdote, and repartee were always at his command, while the varied and exciting scenes through which he had passed and the prominent per-

sonages with whom he had come in contact furnished him an inexhaustible fund of interesting reminiscences. Strange to say, considering his German extraction, he was devoid of any appreciation for music. He spoke and wrote in English, German, French, and Latin, and was also acquainted with Greek.

A notable feature of his scientific work was its systematic character. Evidence of this is furnished by the synoptical tables attached to his several monographs, and by the fact that the analytical table of the *Carices* was one of his productions. The cryptogams had for him an attraction that they do not have for many. We owe most of our knowledge of this series of plants to German, Danish, and Swedish investigators. Knowledge that may not be read by him who runs but must be delved for, as is the case with that relating to the fungi and their near allies, seems to have an especial attraction for Northern minds.

Among his well-deserved honors was the naming after him of *Schweinitzia odorata* (sweet pinesap), by Stephen Elliott. This is a small plant, found from Maryland southward, and bears a spike of flesh-colored flowers which exhale the odor of violets.

A general characterization of the botanist's work can not be given better than in the following words of Walter R. Johnson:

"When we consider the extreme difficulty of the particular departments of botany to which Mr. Schweinitz devoted his chief attention, the prodigious number of facts which he has accumulated, the vast amount of minute and delicate investigation demanded by the nature of the objects of his study, the labor of preparing for the press the materials which he had brought together; when we recollect that, with the exception of Dr. Muhlenburg, of Lancaster, no American botanist had ventured far upon this wide and unexplored dominion of Nature, and when we remember that this science was his relaxation, not his profession—his occasional pursuit, not his daily duty—we are forcibly struck with the high order of his talents for the pursuit of physical science, and can not but regret that more of his time and energies could not have been devoted to this favorite ocupation."

Von Schweinitz bequeathed his collection of plants to the Academy of Natural Sciences of Philadelphia. It comprised twenty-three thousand species of phanerogams and many thousand cryptogams. A large portion of the specimens were from the most remote parts of the world, having been obtained by exchange with American and European explorers. They included the "Baldwin collection" from Florida, Brazil, and La Plata, which von Schweinitz had bought, and in which he had found three thousand species not before in his herbarium. The examination and arrangement of these plants had been one of his last scientific labors.

CORRESPONDENCE.

CLOSE OF THE GLACIAL PERIOD.

Editor Popular Science Monthly:

GEOLOGISTS who are only slightly versed in astronomy are apt to make a serious mistake on this subject. The latest which has fallen under my notice is by Prestwich, in the article entitled The Position of Geology, in the February number of this periodical, page 541. He says: "The last of these astronomical periods was calculated to have commenced two hundred and fifty thousand years and to have ended eighty thousand years ago. These numbers have become stereotyped as those of the beginning and the end of the Glacial period."

A slight acquaintance with this subject ought to prevent mistakes such as the above. They are stereotyped only to those who give little or no heed to the actual dates and as little to a universal law of Nature touching the cumulative effects of constantly acting forces. These effects were clearly set forth by Prof. Le Conte some years ago in treating of this general subject. The day of the summer solstice is not the day of greatest heat or the middle of the hot season; nor is the day of the winter solstice in the middle of the cold season. The maximum in the two cases occurs about six weeks after those dates respectively, an amount about equal to one fourth of the whole time from one extreme to the other. These are elementary truths, and whoever omits them in this discussion repeats the old story of "playing Hamlet with Hamlet left out."

The following is a brief statement of the essential points in the case: Two hundred and fifty thousand years ago * the eccentricity of the earth's orbit was very nearly what it is now, and consequently the climate of these two distant periods, so far as it may depend on the eccentricity, was not very different. The eccentricity had been less, but was then increasing, and had so been for ten thousand years. It continued to increase for about fifty thousand years longer, becoming then nearly three times its present value. Then for another like period it diminished till it became about once and a half its present value. Then again for a second time it increased for about fifty thousand years, becoming about two and a half times the original value. This was one hundred thousand years ago. The decline again commenced, and eighty thousand years ago *the eccentricity was more than double its present value.* It is therefore evident—is plain as an axiom—that the Glacial period did not end then and there. The eccentricity continued to be greater than it is now for twenty thousand years more. And for this long period of *one hundred and ninety thousand years the eccentricity, on the average, was more than twice what it is now.* Those who disregard these facts have not fully grasped the question. It would better accord with truth to say that sixty thousand years ago the Glacial period was making ready "to go out of business."

If we allow only thirty thousand years for the undoing of the effects of the one hundred and ninety thousand—and the allowance is certainly moderate—the close of the Glacial period was only thirty thousand years ago, and that date is comparatively recent when counting geological time. It appears, then, that there is no irreconcilable difference between those geologists who reject Croll's theory by reason of the alleged remoteness of the Glacial period and those who think there "may be something" in that theory. And the more especially is this the case since the recent discovery of the old outlet of the upper lakes through Lake Nipissing and the Ottawa River and the relatively late period when the waters of all the upper lakes began to flow to the sea by way of the Niagara. R. W. MCFARLAND.

COLUMBUS, OHIO, *February*, 1894.

* See American Journal of Science, August, 1880.

DOG PSYCHOLOGY.

Editor Popular Science Monthly:

DEAR SIR: I was greatly interested in Mr. Monteith's article on "The Psychology of the Dog," in the February number, and desire to supplement his paper with some observations of a dog of my own. The animal was a pug—not full-blooded, but with a cross of some other kind; yet he had all the characteristic markings of that breed, and his general appearance was the same, except that his nose was a trifle longer and not so stubby.

"Gyp" was intelligent to a remarkable degree, and from some of his actions I firmly believe that he not only understood what was said to him, but he was capable also of continuous thought, and could reach conclusions. That he understood many words, and could distinguish between them, I am satisfied.

His mistress taught him that when some candy was placed before him, of which he was very fond, if she said, "That's Democrat," he must not touch it, but when the word "Republican" was uttered he at once ate it.

When "Gyp" was thirsty he would go into the kitchen and sit patiently at the sink waiting for a drink; but if, after waiting for

a reasonable length of time, no one came to supply his wants he would utter a sharp, impatient bark.

His happiest moments were when his master would ask him if he wanted to go out walking, and he would express himself very forcibly and unmistakably in the affirmative, and would, if asked at such a time, go to each member of the family, stand upon his hind legs, and give them each a kiss; or, if his master said to him, "Roll over, if you want to go walking," he would at once lie down and roll completely over.

But his reasoning or thinking powers were more clearly manifested in connection with a rubber ball with which he played, and which he would leave in various nooks and corners. When asked, "Where is your ball?" he would, if it was not in plain sight, bend his head down and stand for a moment as if in deep thought, and then proceed at once to get it, sometimes making a quick dive under the lounge, or in a bedroom, under the bed, or behind the curtains that separated the dining from the sitting room, always returning with it, and would look up into one's face, his very countenance intelligent with the answer, "Here it is."

His master generally putting him to bed at night, he usually lay upon the lounge, waiting for the time; and, after the fires had been replenished and the clock wound, he would get down and be ready to go. He invariably waited until the winding of the clock before preparing to start.

In an evil hour "Gyp" strayed away from home one day, and came back a badly used-up dog. He had evidently been attacked by some larger dog or dogs, and after lingering for nearly two weeks he died from the effects of the bites.

During this time he seemed really more like a "human being" than a brute. He was most patient and grateful for all the kind offices and helpfulness of his master and mistress, and heroically submitted to have his wounds washed and medicated, and, although at times scarcely able to walk, he insisted on being where his friends were, or where he could see them.

J. Andrew Boyd.

Ashley, Luzerne County, Pa.

THE "BLUE LAWS" A MYTH.

Editor Popular Science Monthly:

"The early Puritans of New England, who enacted the most ferocious of blue-laws, who would not let a man step over a stone in his path, or kiss—not his neighbor's but his own—wife on a seventh day," etc.

The above is a quotation from the very first page of an article, in the last number of The Popular Science Monthly, entitled Abolish All Prohibitive Liquor Laws, by Appleton Morgan. Now, these mythical blue laws never had any existence; no law forbidding a man to kiss his wife on the seventh day was ever on the statute-books of any New England colony. Prof. Johnston's History of Connecticut, in the American Commonwealths Series, or Palfrey's History of New England, will show the origin of this absurd myth. A glance at Blue Laws, and the Rev. Samuel Peters, in either Appletons' or Johnson's Cyclopædia will perhaps be enough for the ordinary reader.

Such careless misstatements naturally cause the reader to question the accuracy of the entire article. As you say in your editorial comments on the "young moon" error, "writers, and particularly writers on scientific subjects, are under obligations to know what they are talking about."

Charles E. Davis.

Washington, *February* 20, 1894.

EDITOR'S TABLE.

THE UNEMPLOYED.

When a condition of things supervenes in which a considerable percentage of the population is cut off from the means of support by lack of work, we need not hesitate to say that something is wrong. We are not much in the habit of attributing purpose to Nature; but the language of teleology is sometimes convenient, and we shall perhaps not be misunderstood if we say that the apparently enforced idleness of thousands of men, with all the poverty and distress thence resulting, can not be part of Nature's plan, or at least can not illustrate the normal working of natural law. Nature, we know, is severe in her methods, and recks little of human life when she sets her forces of fire and flood, of storm and earthquake in motion. There is nothing analogous to these catastrophes in the social phenomena before us to-day. What we see is not the sudden extinction of human

lives by uncontrollable physical forces, but the prolonged misery of human beings through lack of adaptation to their circumstances or through the existence of artificial conditions of purely human production. To our mind the question of the hour presents itself in this shape: Why is there so terrible an amount of maladjustment in social relations to-day? Why are such multitudes so fatally out of harmony with the conditions of life? The symptoms, as we interpret them, all point to man's tinkering with natural laws in a futile effort to amend them, or with the shameful object of benefiting the few at the cost of the many. We wish briefly to indicate one or two of the ways in which, as it seems to us, social misery is caused.

It is recognized the world over that republican institutions are the definitive form of government for civilized countries; but when our forefathers struggled for liberty they probably had little idea of the form which popular government would in these latter days assume. They did not foresee the unrest that would be introduced into every section of the country through the desire to share in the emoluments which government has the power to bestow. They did not foresee the creation of a class of professional politicians who, reaping pecuniary rewards themselves for their political services (so called), would be empowered to dangle minor rewards before the eyes of scores of others by way of securing support for themselves. They did not foresee the greedy passions and the aversion to steady employment which all this would arouse, or the numbers of half-employed and unemployed men whom it would throw upon the community to live more or less the life of adventurers. They did not foresee the paralysis that would overtake both law and legislation through the balancing of selfish interests, or the deadness to large views of policy which the constant study of all political questions from a local standpoint would entail. While curbing the power and curtailing the privileges of a territorial aristocracy, they had no prevision of a moneyed class which, allying itself with the dominant party in the state, would wield a power more dangerous to national welfare than any aristocracy had ever done. We, however, see that all these things have come to pass, for we live in the midst of them and feel the burden of them every day. The remedy lies not in any reversion to outworn institutions—though diseased commonwealths have many times taken refuge in tyranny—but in the sedulous cultivation of a higher sense of citizenship. How is that going to be done? some one will ask. Do you believe in it yourself? we rejoin. Do you believe that the average sense of citizenship, or, to express it otherwise, the average sense of duty to the state, is low; and, if so, are you personally willing to set a higher example and courageously and strenuously uphold a higher doctrine? If so, you need not ask how the thing is going to be done, for you see the way yourself. If not, we do not wonder at your skepticism as to that being possible which you are personally unwilling to undertake. There are a hundred ways in which higher views of citizenship might be inculcated. The country is fairly riddled and honeycombed and worm-eaten with secret societies, the object of each being to confer special advantages on its members, the object of none being to raise the political and moral tone of the whole country. Could not some of the leaders of these move in the matter? Then there are schools, public and private, where ample opportunity exists for forming the minds of the young aright on this most important subject. Then there is the pulpit, which might be an enormous engine for good if rightly used.

The question just now, however, is how the dislocations which are causing so much misery have been brought about, rather than what specific meas-

ures are necessary to mend them. If we see whence our trouble has come, we shall not be at any serious loss as to remedies. The faults of our political system, or rather the vices which attend its practical working, are closely connected, in our opinion, with a defective system of popular education. The public-school system is a gigantic creation of law. It did not *grow* any more than the tariff; it was *made*, and made under the influence of arbitrary conceptions as to what a school system for the whole people should be. Being made for the whole people, special adaptations could not be thought of. Consequently, the work it does is like mill work, and all who come out of it show one uniform pattern. There is no cultivation of individuality, and, broadly speaking, all ideal elements are banished from the education imparted. The result is that the one really dominant trait in the swarms of youths sent out year after year from the public schools is a consuming desire to make money, and to make it in the easiest way possible. What the state has done is not so much to educate in any worthy sense, as to increase the keenness of competition by promoting an unnatural uniformity of tastes and aims. And, as the universal ambition is not only to make money but to make it fast and easily, it is not surprising that those who do not see how they are going to do this by honest means betake themselves to means that are not honest. It would be an interesting and instructive thing to know how many school-bred young men are at this moment engaged in various forms of "fake" business. What these individuals learned at school was that education was chiefly useful as a means of making money, and now they are trying to turn their education to such account as they find possible.

If habits of industry were taught in the schools, that alone would be a great gain; but in general it is not so. The idle have ample opportunity to idle, and even those who have no natural propensity that way are more or less habituated to idleness, owing to the simple fact that the teachers are not able to keep their classes fully occupied. That much moral harm is thus wrought to thousands of boys we have no doubt whatever. Then education is not valued, simply because it is apparently so cheap; and this again has a vulgarizing and demoralizing effect. Education ought to be valued, and, if it is not, it will be lacking in the moral virtue which it ought to possess. It may further be asked whether the drill of school renders those who are subjected to it more resourceful or less resourceful. Is there not a danger lest a habit be formed of looking for direction and not exercising individual powers of thought and will? We have no wish to dogmatize on such a question, but the conclusion to us is irresistible that the public-school system, as a whole, is a vast attack on the individuality of the rising generation, and that by destroying natural dissimilarities between the units of the population, and thus making competition fiercer, it throws a great number out of adjustment to their environment, either as destitute of employment or as in a manner compelled to some more or less criminal means of making a living.

It is a most unpopular thing, we are aware, to hint at the possibility of "over-education," but might we venture to suggest that there may be, and is in a multitude of cases, misplaced or superfluous education? A man not only does not need a university degree to enable him to drive a street car, but the possession of a university training is not likely to sweeten for him that particular kind of toil. We hold it to be entirely possible to supersaturate a community with university "advantages"; money liberally, vigorously, and unwisely applied will do it.

We fully believe that other elements than those we have indicated enter into

the problem of the unemployed. It is probably true, as hinted by Herbert Spencer in the address delivered by him in this city in the year 1882, that the pace set by the stronger and more competent members of the community is faster than the weaker ones can keep up with. "In the country of the blind the one-eyed man is king," and many of the "failures" of a civilized society might be brilliant successes in a society of a more primitive cast. So far as an unrestrained use by the strong of their superior abilities in competition for wealth and all that it represents may be an evil—and that it is an evil Mr. Spencer has again suggested in the last volume of his Principles of Sociology—we can only hope to check it by promoting the growth of higher moral and social sentiments. This will, in any case, take time; but meantime we should earnestly and sedulously consider in what directions and to what extent we are interfering with the operation of those natural laws the tendency of which is to produce a condition of social equilibrium. We need to open our eyes to the mischief we have done by a crude political philosophy, by unwise legislation, by indiscreet philanthropy, by the application of untried abstract ideas to the regulation of social questions. We need to awaken to a sense of the extreme liability of the human intellect to go astray when it attempts constructive work of any kind. That things have gone wrong we have the proof before our eyes, and where is the chief blame to be laid if not on our own short-sighted views and meddlesome policies?

It happened that just as we had finished the above article the Fortnightly Review for February was placed in our hands. The first article in the number is one by Herbert Spencer upon the late Prof. Tyndall; the second is by Goldwin Smith, and bears the title of Oxford Revisited. From the first, which will be found entire elsewhere in this number, we extract the following passage: "A conversation with him [Tyndall] some years since made it manifest that personal experience had greatly shaken his faith in public administrations, and made him look with more favor on the view of state functions held by me. On the other hand, my faith in free institutions, originally strong (though always joined with the belief that the maintenance and success of them is a question of national character), has in these later years been greatly decreased by the conviction that the fit character is not possessed by any people, nor is likely to be possessed for ages to come."

From the second article we take the following: "It may be said without reference to university extension or to any educational movement in particular, and it is to be hoped without incurring the charge of illiberality or obscurantism that people will have presently to consider the economical as well as the intellectual effects of pressing on everybody what is called high education. The good founder of Cornell University once confided to a friend his hope that the day would come when there would be five thousand students in his institution. His friend replied that if that day did come the institution, instead of being a blessing, would be in danger of being a curse, since there would not be a market for anything like such a number of graduates, and the residue would be without suitable work, unhappy, discontented, and probably dangerous to the commonwealth."

Whether we agree with these sentiments or not, let us ponder them. Of both writers it may be said that they are men of strong practical instincts.

WHY BENEFICENCE SHOULD NOT BE ENFORCED.

In a criticism of Mr. Spencer's Principles of Ethics in the January number of Mind, Prof. S. Alexander asks a question which, it seems to us, admits of an

easy answer. Referring to the position taken by Mr. Spencer that justice should, but that beneficence should not, be enforced, he asks why this should be, if the warrant for beneficence equally with that for justice lies, as Mr. Spencer seems to admit, in the public good. The answer we conceive is this: that while beneficence, wisely practiced, is a public benefit, the enforcing of it would not be a public benefit, inasmuch as it would tend to kill the sentiment itself. If, for example, the moment a beneficent action became possible for us some power should seize us and force us to a performance of the action, we can hardly imagine any other result than that the very instinct of beneficence would die out. Another answer is that whereas justice is essentially of the nature of non-interference, beneficence is essentially of the nature of interference. The motto of the one is "Hands off!" For the other we would have to coin the motto "Hands on!" Now, the difference between establishing in government the principle of "Hands off!" and establishing that of "Hands on!" is obvious. The former is not only workable, but is the necessary condition of all free individual effort; the latter is unworkable in any consistent manner, from its absolutely indefinite and unlimited character. If beneficence is to be enforced, where are we to begin and where can we possibly end? Again, imagine the effect on weak individuals of knowing that beneficence toward them will be enforced. What interest have they henceforth in ceasing to be weak? Finally, beneficence administered by the state is not beneficence in the true sense, and can have none of the effects of true beneficence; for the state can only properly take what it has a right to take and give what it has a right to give, and the beneficiaries in the case supposed would be quick to draw the inference that they were getting no more than their due. Thus would the limits of justice be obscured and social stability endangered. On many grounds, therefore, we think the distinction Mr. Spencer draws a sound one.

POINTS IN LIBRARY MANAGEMENT.

The report of the Library Committee of the Public Library of Cleveland, Ohio, for the year ended August 31st last, has come into our hands. Two remarks made in it have arrested our attention. One is to the effect that "it is a singular and deplorable fact that, of all the money so lavishly expended by the many rich men and women of Cleveland in various benevolent and charitable enterprises, not one cent has ever been given either toward the erection of a library building or to help to support the library." Elsewhere it is stated that "our library has never had the use of any money except such as came by taxation."

Well, whether or not there is anything "deplorable" in this, we can not say that we find the fact at all "singular." Taxation and benevolence are two things that do not naturally mingle. The Cleveland Public Library seems to have been in operation since 1869, and it has doubtless come to be looked upon as a department of the city government. Had taxation not been resorted to for the formation of a library, there is no knowing what private beneficence might not have done ere this. When the State takes up a function, it is a kind of hint to private enterprise to drop it. Why should a private individual subsidize a tax-supported library any more than a tax-supported post office?

The other remark above referred to is that "the plan of permitting free access of patrons to the shelves, adopted some time since with some misgivings, continues to give increased satisfaction to those using the library. . . . Not only," the report continues, "has this new method given great satisfaction to those desiring and drawing books from the library, but it has also enabled us to

issue more books with very much less labor and expense than under the old conservative system which previously prevailed. Nor has this free access to the shelves resulted in loss of books or damage to the same." This statement is very satisfactory. Many of the restrictions which surround public institutions and which hamper the work of government are general rules adopted to meet very limited evils. Instead of meeting the limited evil and overcoming it by watchfulness and such special measures as may be called for, a general rule is adopted which operates as a burden on a large number of persons for whom no such rule is necessary. Such is the stupid instinct of governments always and everywhere, we might almost say; and it is also one of the chief ways in which government is rendered expensive, as the authorities of the Cleveland Public Library seem to have found out. We congratulate them on having made a useful discovery, and we trust that their experience will lead other similar institutions into the right path.

One little observation before we leave this topic. In the list of newspapers and periodicals on file in the reading room of the library we notice but one in the French language, and that is—what? The Revue des Deux Mondes, or the Nouvelle Revue, or the Revue Bleue, or even the Courrier des Etats-Unis? No, but the Mode de Paris. All that French periodical and newspaper literature contributes to this tax-supported institution is a fashion paper. May we suggest that, if a German one is wanted, Modenwelt is not bad in its way. Let literature flourish!

LITERARY NOTICES.

Genetic Philosophy. By David Jayne Hill. New York: Macmillan & Co. Price, $1.75.

The author of this work undertakes to treat the principal problems of philosophy by a method which, though he does not assert it to be entirely new, he does not believe has been systematically carried out by any previous writer. He applies to his method the term "genetic," and he explains that it "consists in referring every fact to its place in the series to which it belongs." Such a method, of course, is essentially the method of science, and what we recognize in the work before us is not so much any originality of method as a skillful and interesting application of a well known method to a number of interesting and important philosophical questions. There is nothing, for example, very original in the following declaration of principles, but it is well expressed: "Being, as apprehended by our intelligence, is found to possess continuity, and all facts are the aspects of a process. When, therefore, facts are translated into thought, they must not be sundered and isolated, floated off from their attachments and treated as independent entities. The continuity which connects them as real must also connect them as ideal. In other words, they must be genetically regarded, or considered as aspects of a continuous process to which they must be referred."

Among existing philosophical schools that to which President Hill most inclines is evidently the evolutionist as represented by Herbert Spencer. He criticises the latter, however, for placing the Unknowable in the forefront of his system, and then afterward hustling it out of court as "deserving of no consideration from the minds of adults." We can hardly admit this to be a correct account of Mr. Spencer's procedure, but the point is not one that admits of discussion in this place. He says, again, that to Mr. Spencer "the universe is like a great music-box which can play but one tune." How many tunes, one might ask, does a strictly "genetic" philosophy provide for? Any limitation in this respect must come from the recognition of necessary sequence, and such recognition is as much a feature of our author's mode of thought as of Herbert Spencer's.

On the subject of the Genesis of Matter, which constitutes the first chapter (following the Introduction) of Mr. Hill's book, we are not told anything new, or rather we are not told anything at all; what we are told relates entirely to the supposed constitution of

matter, a somewhat different thing. What the author has to say, however, he says well, and the whole chapter constitutes an interesting exposition of modern views in regard to the material universe. It is a mistake to say, as he does on page 48, that "it was Bode's law which led Leverrier and Adams to assign a position to an unknown planet from the anomalous movements of Uranus." Bode's law simply assigns approximately the distance from the sun and from one another of the planets of our system, but says nothing as to the position in its orbit which a given planet shall occupy at a given time; and in searching for the undiscovered planet its position in its orbit and not its distance from the sun was the point to be determined. The chapter is concluded with a verse from Omar Khayam:

> "Shall any gazer see with mortal eyes,
> Or any searcher know by mortal mind?
> Veil after veil will lift—but there must be
> Veil after veil behind."

So far, therefore, as the genesis of matter is concerned, the Persian poet of nearly a thousand years ago expresses the thought of the "genetic" philosopher of to-day.

In Chapter II, on The Genesis of Life, the author frankly and fully accepts the doctrine of evolution. "At present," he says, page 63, "there is probably no biologist of importance who does not accept organic evolution as a real process of Nature, although there are various degrees of conviction as to the sufficiency of the explanation of the causes which have been operative in the natural history of descent." As between the conflicting views of Weisman and Spencer, Mr. Hill rather inclines to the side of Spencer, but we do not judge that he speaks as a biologist, or that he has mastered all the arguments on either side of the question; at the same time the discussion, considering the limits within which it is confined, is ably done and will be useful to the general reader. Under the head of The Genesis of Consciousness, again, we have an interesting review of modern speculation respecting the conditions of consciousness, but no really distinctive view as to its origin. The author states his conclusion to be that "while psychic elements are manifested to us directly only through consciousness, they exist as its preconditions; and, therefore, are not to be denied existence beyond the sphere of consciousness." Goethe had said as much in his celebrated aphorism that Nature "sleeps in the stone, dreams in the animal, and wakes in man." Schopenhauer too, makes Will, which is decidedly a psychic element, pervade the whole universe. "Unless every analogy of Nature is violated," observes the author, "what we call the 'soul' had its being long before it came to consciousness"; and holding this view it is not to be wondered at that he looks with decided favor on the doctrine of metempsychosis.

The remaining chapters of the book deal with the Genesis of Feeling, of Thought, of Will, of Art, of Morality, of Religion, and of Science. All are characterized by liberality of thought and are interesting in a high degree. There is excellent matter in all these chapters, particularly in those on Will, Morality, and Religion. The author denies that pleasure is Nature's end, asserting that it is merely Nature's means toward higher ends, a view which we think has much to commend it. On the subject of the connection or relation between (physical) energy and will he takes up much the same position as Schopenhauer. "By what right," he asks, "is the objective series elevated to the dignity of a causative order and the subjective series regarded as inconsequential?" As regards the development of morality, he seems to accept Herbert Spencer's analysis as far as it goes, but finds it too abstract, too merely schematic, if we may use the expression. His own statement of the matter is that "the evolution of morality is the gradual formation of a moral consciousness through the perception of what is *due* in the relations of social life." Sin he defines as "the persistence upon the human plane of tendencies which belong to the animal plane, and which should therefore have been subjected to the law of reason. From the moral point of view," he adds, "to be carnally-minded is death." In the chapter on the Genesis of Religion the author holds that, while Mr. Spencer's theory which assigns the origin of all religion to ancestor worship will explain much in the way of religious ceremonial the world over, it will not explain everything, and particularly will not explain the origin of the religious sentiment.

"The order and progress of the world," President Hill maintains, "the ideals which press upon us for realization—these are the secure foundations of religious faith. The unity of the world, the immanent rationality of its processes, the beneficence of law, the imperative authority of duty—these are the corner stones of religious life and hope." His own definition of religion, however, is "belief in a superhuman being or beings regarded as objects of worship"; and the question is how, without some such hypothesis as Mr. Spencer's, or without a primitive supernatural revelation—a conception which the author puts aside as totally insufficient and having only a verbal meaning—to explain the origin of such belief. That question we do not consider he has solved. In concluding this notice we leave many interesting points untouched; but we wish to say that the book as a whole has great merits; it is perspicuous and scholarly in style, vigorous in thought, candid in tone, excellent in matter, and altogether a very creditable addition to American philosophical literature.

A Theory of Development and Heredity. By Henry B. Orr, Ph. D., Professor at the Tulane University of Louisiana. New York and London: Macmillan & Co., 1893. Pp. ix + 255. Price, $1.50.

The author states in his preface that he believes that by a critical review of the facts of biology in the light of the great conclusions derived from the allied sciences of physics and psychology we may obtain a view of the great phenomena of life that shall bring into harmony a more extensive range of facts, and explain intelligibly relations that have hitherto been hidden.

He sums up a scheme of the course of development by premising a primitive mass of protoplasm which acquires nervous co-ordinations that influence its activity and growth: as it divides and redivides, it adds continually new co-ordinations to those already acquired, and by repetition the process of growth and development has the character of reflex action. As the same forces act on each generation, and form a series of stimuli that are similar for each generation, so each generation repeats in its life the course of development followed by all its ancestors. These different phases of one process constitute his explanation of growth, development, and inheritance. According to this, in our own development we must recognize ourselves and our actions as the result of a definite, accurate activity of creative force.

The author sees what is the last analysis of such a theory of development and life, that our ideas of free will and moral responsibility are paradoxical: but we do not see on what grounds he believes such a paradox is capable of satisfactory solution, even though we are all convinced that we have a certain degree of freedom of will. Would it not be better to abandon the idea of free will and hold that will is the expression of hereditary tendencies modified by environment—a theory that, at present, the author strongly inclines to?

Prof. Orr's book is interesting, and is a satisfactory explanation of the evolutionary theory of development and heredity.

Lectures and Essays on Fevers and Diphtheria, 1849 to 1879. By Sir William Jenner, Bart., G. C. B., M. D. Lond., and F. R. C. P., D. C. L. Oxon., LL. D. Cantab. and Edin., F. R. S., etc. New York: Macmillan & Co., 1893. Pp. xii + 3 to 581. Price, $4.

This volume is a collection of papers that the author published between 1849 and 1879 in various medical journals of Great Britain.

The first essay, on the identity or non-identity of typhoid and typhus fevers, is dated 1849-'50, and is founded on a statistical analysis of a series of cases observed during two years at the London Fever Hospital.

The second essay is devoted to proving that the causes of typhus, of typhoid, and of relapsing fever are separate and distinct, a fact by no means currently accepted in 1849. This topic is further elucidated in the third essay.

The fourth essay, on the acute specific diseases, formed the Gulstonian Lectures of 1853.

The second section of the volume consists of three clinical lectures, two on diphtheria and one on croup and diseases that resemble it.

All these essays demonstrate the careful and critical observation displayed by the author in his clinical work, and the volume

forms a useful contribution to the history of medical progress in the nineteenth century.

A Text-book of Physiology. By M. Foster, M. A., M. D., LL. D., F. R. S., etc. Sixth edition. Part I, comprising Book I. Blood; The Tissues of Movement; The Vascular Mechanism. New York and London: Macmillan & Co., 1893. Pp. 387. Price, $2.60.

The popularity of this text-book is evidenced by the fact that a few months after the final part of the fifth edition was published the author presents the first part of the sixth edition. We find but few changes in the present volume except in the chapter on the vascular mechanism, in which descriptions have been introduced of the membrane manometer of Hürthle, of Stolnikow's method for determining the quantity of blood ejected by the ventricle, and of the cardiometer of Roy and Adami. In a number of sections the text has been rearranged, but with no additions that are of signal importance.

Essays by Thomas H. Huxley. Vol. I. Method and Results. Pp. 430. 1893. Vol. II. Darwiniana. Pp. 475. 1893. Vol. III. Science and Education. Pp. 451. 1894. New York: D. Appleton & Co. Price, $1.25 each.

These are the first volumes of a series intended to include the collected essays of Mr. Huxley. The first contains a brief but characteristic autobiography, and nine essays that were published between 1866 and 1890. The author states that while they are neither free from repetitions nor, perhaps, deficiencies, yet as far as their substance goes he finds nothing to alter in them. This, we opine, is rather an evidence of the soundness of his opinions than of failure to make progress in wisdom during the last quarter of a century.

The essays include that on the advisableness of improving natural knowledge, that on the progress of science, on the physical basis of life, on Descartes's discourse touching the method of using one's reason rightly and of seeking scientific truth, on the hypothesis that animals are automata, on administrative nihilism, on the natural inequality of men, on natural and political rights, and on government.

The second volume contains essays on the ancient doctrine of evolution, rehabilitated and placed upon a sound scientific foundation, since and in consequence of the publication of the Origin of Species. These essays meet the criticisms imposed upon Mr. Darwin's great work, and sum it up and indicate its enduring influence on the course of scientific thought. The volume includes three essays—on Charles Darwin, on the Darwin memorial, and an obituary of Darwin—that record the impressions left by that scientist on his friend for thirty years, the author of this volume.

The third volume contains seventeen essays that were published between 1854 and 1887, all of which refer to the value of science in education.

Some of these essays have appeared in pages of the Monthly, but the many admirers of Prof. Huxley will be glad to welcome this permanent collection of his writings that have done so much to advance the scientific spirit of our age.

Jesus and Modern Life. By M. J. Savage. With an Introduction by Prof. Crawford H. Toy. Boston: George H. Ellis. Pp. 229.

In this work the author has sought to find out, so far as is to-day possible, the actual beliefs and teachings of Jesus. Then, having, as he has supposed, had this teaching, he has considered it as relating to the preceding thought of the world, and specially of his own people. After that he has tried to find out how much of this teaching is vital to-day, and how it bears on the problems, religious and other, with which we must deal. "Only in some such way as this," he assumes, "can we really find out to what extent and in what sense Jesus is a present leader and inspiration."

The New Bible and its New Uses. By Joseph Henry Crooke. Boston: George H. Ellis. Pp. 286.

In this book the Bible is considered in the light of the modern or "higher" criticism, by which, the author holds, the theories of our fathers respecting its origin, growth, and character have been swept aside. As a result, "we see with greater clearness the impulse and purpose which produced these writings. We understand the

human conditions which gave them birth, the limitations as well as the nobility of the authors who penned them. We appreciate the greatness of their varying messages, but we also trace the burning lines of error and passion which mar these pages. There is truth enough to make them grandly human; there is superstition enough to prove them no more than human."

A History and Description of the Modern Dogs (Sporting Division) of Great Britain and Ireland. By Rawdon B. Lee. London: Horace Cox. Pp. 584, with Twenty-six Plates.

The author has attempted in this book to summarize the progress and describe the varieties of the sporting dogs as they are at present known and appreciated in the British Isles. Without losing any of the early history, his wish has been to introduce matter bringing the subject up to date; both so far as the work of dogs in the field is concerned, and in viewing them as companions, and when winning, or attempting to win, prizes in the show ring. After this method full accounts are given of twenty-nine varieties or "sports" of dogs, with historical information, anecdotes, gossip of the market and the kennels, discussion of values, the points by which the kinds are distinguished, and qualities; constituting the book of great value to all who are interested in breeding, using, or admiring dogs. Of the illustrations, only two—those of the greyhound and of the Kerry beagles—are actually portraits. The others, though originally drawn from living examples, are rather typical specimens of the various breeds they represent.

Object Lessons and How to Give Them. By George Ricks. First Series. For Primary Schools. Pp. 202. Second Series. For Intermediate and Grammar Schools. Pp. 214. Boston: D. C. Heath & Co. Price, 90 cents each.

The primary purpose of lessons in common objects and natural phenomena, the author believes, is to cultivate the senses, to train the habits of attention, intelligent observation, and accurate comparison, and so lead up to the higher processes of the mind—reason and judgment. The natural course of the teacher would seem to be to gather up into something like order and to perfect what has so far been imperfectly accomplished by the child, and to evolve from this as a basis a systematic course of training; and the teacher who would best succeed should take childhood's method of imbibing knowledge and adapt it to her own use. The child, as Spencer says, should not be told or shown, but taught how to observe. The lessons in the first series are intended to be short, simple, pleasing, and attractive, and relate to objects of sense, common articles, and the simpler qualities. Those of the second series relate to the common properties of solids, liquids, and gases, in that order, and to those matters which demand closer observation and exercise of the reasoning faculties. They are suggestive rather than exhaustive.

Suicide and Insanity: A Physiological and Sociological Study. By S. A. K. Strahan, M. D., Barrister-at-Law, etc. London: Swan, Sonnenschein & Co., 1893. Price, $1.75.

The author states that he has endeavored to trace modern suicide to its source, to show how large a percentage of what is really avoidable is deliberately propagated, and how closely it is related to those other abnormal conditions met with in all civilized communities. The cause of suicide is cultivation, and it is propagated by the intermarriage of the insane, the epileptic, and the criminal.

Suicides are divided into two major classes—rational or quasi suicide and irrational or true suicide. The former class is further subdivided into, first, those who destroy their life for gain, consisting of religious devotees, of those who die to follow friends, of those who die to gain notoriety, and of those who die that others may gain. Second, those who commit the suicidal act that they may escape some real and impending evil that is considered more terrible than death.

Irrational suicides are divided into three groups: First, that in which there is mental aberration; second, that in which the act depends upon an irresistible impulse and in which there is no mental aberration; third, that in which a certain predisposition makes it possible for a slight shock, trial, or irritation to awaken the unnatural impulse.

As statistics show that suicide is on the

increase among all civilized peoples, whether their racial predisposition be great or small, and as racial proclivity remains fixed, the author concludes that all, or nearly all, the increase must be the outcome of the acquired or pathological character.

The influences of race, of climate and season, of religion, and of sex and age are considered as factors in causing suicide.

In regard to the stand taken by the law in reference to suicide, the author says that he does not believe that pronouncing suicide a crime has ever stayed the hand of a single individual bent on self-destruction, and the law has never been able to punish the criminal in a single instance, nor can it hope to. There are only two logical courses open to those who would reform this legislative absurdity. One is to sweep away all legislation upon the subject so far as it relates to the individual himself, no longer consider suicide a crime, and ignore attempts thereat. The other is to enact that all attempts at suicide, whether successful or not, be in themselves conclusive evidence of dangerous insanity. The author, agreeing with the Sophists, Stoics, Epicureans, and Platonists, believes that the first of these two is the more just and sensible course.

The author considers the theological, naturalistic, sociological, and moral objections to suicide, and concludes with old Dr. Donne that "self-homicide is not so naturally sin that it may never be otherwise."

The author has presented a very interesting and unbiased study of a topic that is engaging more and more attention, for it is not one of the least of the charges against modern society that its organization is such that men and women are unwilling to continue as associates thereof.

The Technique of Post-mortem Examination. By Ludvig Hektoen, M. D., Pathologist to the Cook County Hospital, Chicago. Chicago: The W. T. Keener Company, 1894. Price, $1.75.

The author is to be congratulated on this little work that is a concise exposition of the various matters connected with the performance of post-mortem examinations. He has not endeavored to enter into a systematic and minute consideration of the pathological changes in the organs, but rather he has made it his aim to give such general and comprehensive information as is needed by the examiner.

As no State in the Union has prescribed regulations to guide and direct the practitioner in the method of making necropsies in medico legal cases, it is believed that the systematic procedure detailed in this book will make it useful to all practitioners of medicine likely to be called upon to perform such duty.

The work is admirably printed and illustrated, and is one of the best books on this topic with which we are acquainted.

Myths of Greece and Rome. By H. A. Guerber. New York: American Book Company. Pp. 428. Price, $1.50.

Students of literature and art will find a most attractive handbook in this volume.

While it does not take the place of a dictionary of reference, where every dryad may be traced to her favored tree by the classical scholar, it includes all the more important myths celebrated in song, sculpture, or painting.

The illustrations alone comprise seventy-one reproductions of famous works of art. The text is bright and interesting, and in conclusion an analysis of myths is given, the philological interpretation receiving the preference. The work is also generously furnished with aids to the reader, containing a classical map and genealogical chart as well as glossary and index.

William Kitchen Parker, F. R. S. A. Biographical Sketch. By his Son, T. Jeffery Parker. London and New York: Macmillan & Co. Pp. 145. Price, $1.50.

Although naturalists generally are impelled to their life work by an ardent love of Nature, it is rare to find among them in early youth such glowing enthusiasm as that exhibited by William Kitchen Parker.

The son of an English farmer, only a scanty education had been afforded him when he began, as a lad, his loving study of bird and flower in his father's field. Apprenticed at the age of fifteen to a druggist, he read physiology while compounding sheep ointment, and rose at four o'clock in the morning to have three hours' botanizing in the woods. In two summers he had collected

and preserved five hundred species of plants, and laid the foundation for a thorough acquaintance with botany. He was next placed with a country surgeon, and here undertook by himself the study of comparative anatomy, dissecting animals and birds, and executing drawings of marvelous exactness and beauty. It may well be credited that at fifty years of age he had produced more original work than any other English anatomist. His zest for knowledge and keen enjoyment of Nature never waned. At sixty-five he writes: "The sight of the wild flowers, the settling of a speckled, metallic feathered starling close to me, and the song of the lark made weariness a trifle; . . . the joy of research has been the wine of my life." A characteristic portrait is the frontispiece to the memoir, and a list of published works is given at the close, these being mainly upon the foraminifera, the vertebrate skeleton, and skull.

Handbook of Public Health and Demography. By E. F. Willoughby, M. D. London and New York: Macmillan & Co. Pp. 495. Price, $1.50.

This volume constitutes the third edition, enlarged and revised, of a former work, the Principles of Hygiene, by the same author.

The subject is treated in four main divisions—health of the man, health of the house, health of the city, and health of the people. In addition to these there are chapters on demography, meteorology, and sanitary law.

Much space is given to the section on dietetics, where somewhat of the changes involved in nutrition are explained according to the experiments of Pettenkofer and Voigt. The prevalent error is noted of confounding oxidation with metabolic processes in the body. The value of a food depends upon the ease with which it digests, splits up, and combines in the organism, not upon the constituents *per se*.

Common snares are also pointed out in the food that does not nourish, the filter that is worse than useless, the barometer which measures nothing, the disinfection that does not disinfect, and the statistics that prove a trap for the unwary. But the effort of the book is mostly constructive, and there is much in it that is valuable for the student of statistics and the householder. The unfortunate schoolgirl may, if it falls into her hands, drop it with righteous scorn. The chapter on school hygiene is disfigured by a thrust at feminine ability and the threadbare plea that woman's health suffers in the educative process. The author, illogical enough, gives the best possible reply to this in his dissertation on exercise, where he informs us that most of the ailments of women would be prevented if girls strengthened their muscles as their brothers do!

The Child, Physically and Mentally, is considered by *Bertha Meyer* in a small pamphlet translated from the German by Friederike Salomon and published by the M. L. Holbrook Co. A similar work was written by the author thirteen years ago, and this is intended as a supplement, embodying the more recent teaching of hygienic science. It is curious to note that it contains only two pages of suggestion for the mother who desires to rear her child in the natural way. This is certainly not all that should be said on the subject in a country where infant mortality is exceptionally high. An appendix is needed to justify the aim and title of the *brochure*.

The Arithmetic of Magnetism and Electricity, by *John T. Morrow* and *Thorburn Reid*, a little handbook of 145 pages, consists of the statement and explanation of those facts and laws of electricity and magnetism which are especially connected with their practical and commercial aspects. It contains among other matters chapters on General Laws of Electric Circuits; Batteries, Primary and Secondary; Direct-current Dynamos and Motors; Alternating current Dynamos, Motors, and Transformers; Lighting and Power, and The Application of Electrical Laws to Electrical Railways; with some useful tables. (It is published by the Bubier Publishing Company, of Lynn., Mass., at $1.)

A System of Analysis of Milk and Milk Products, containing results of the latest researches, is given us by *Leffmann* and *Beam*. Most of the earlier processes have been superseded or at least greatly modified in the past few years by the large amount of original work done, more especially under the supervision of the Society of Public Analysts. The book is intended not only for professional chemists, but also for practical dairymen, and to such it ought to prove

a great aid. It contains an appendix consisting of useful tables for calculating total solids, etc. (It is published by P. Blakiston, Son & Co., Philadelphia. Pp. 89. Price, $1.)

A collection of *Bulls and Blunders*, compiled by *Marshall Brown* (Griggs, $1), has recently been issued. It is a large and amusing collection, and besides being amusing it is instructive, for where the blunder consists in a faulty arrangement of words, the way to correct it is pointed out.

Under the title, *The Monism of Man*, *David Allyn Gorton*, M. D., has put forth a mingled mass of scientific facts and supernatural speculations (Putnam, $2). The book is a hard one to describe. It is not a descriptive treatise on the subject indicated by its title, for it does not even tell anywhere what the "monism of man" is. It can not be called a disputation, for it does not attempt to prove anything in particular. It is rather a pleasant, extended essay, in which a man versed in a scientific profession and well read in classic literature and religious lore has set down some things that he knows and others that he believes, together with many quotations from favorite authors, and his own reflections upon the material thus brought together.

From the University of far-away Tasmania comes, by way of an English printing office, an essay on *Utility of Quaternions in Physics*, written by *A. McAulay*, in competition for a prize offered by the University of Cambridge (Macmillan, $1.60). In a long and free-spoken preface the author states that the physical applications of quaternions are sadly neglected at Cambridge, in spite of Prof. Tait's powerful advocacy. He ranks himself as a disciple of Prof. Tait in promoting the study of this branch of mathematics, but feels compelled to differ from his master on certain points, some of which he sets forth in his preface. The divisions of physics to which he applies quaternions in this essay are elastic solids, electricity and magnetism, hydrodynamics, and the vortex atom theory. At the risk of being deemed a misdirected enthusiast he hopes for a "time when quaternions will appear in every physical text-book that assumes the knowledge of (say) elementary plane trigonometry."

In the *Elements of Life Insurance*, the author, *Miles M. Dawson*, has sought to give the reader a comprehensive and accurate conception of life insurance, without burdening his mind with needless technical terms; to write what will be most useful to beginners and so as to be intelligible to the general public mind. Besides the analysis of rates and reserves, the scope of the book covers the subject of contracts; their construction, application, nature, and legal effect. Insurance is defined as the equalization of fortune. By its provisions, a large number of men arrange to lose small sums in order that none of them may lose a great sum in a specified way. Thus it is the alliance of prudent men against misfortune. The book is published by the Independent Printing and Publishing Company, Chicago, at the price of two dollars.

The Outlines of Embryology of the Eye—the Cartwright Prize Essay for 1893—by Dr. *Ward A. Holden*, is the product of a study carried on at the New York Ophthalmic and Auric Institute, and is based upon the examination of a great number of specimens of eyes of chicks and pigs. Endeavoring to give a clear and comprehensive description of the development of the organ, the author has deemed it best to present first a brief and purely schematic sketch of the processes which take place, explaining them with diagrams, and next to give an accurate histological description of the various parts of the eye in their successive phases of development, illustrating these descriptions with careful drawings from actual preparations. (Published by G. P. Putnam's Sons. Price, 75 cents.)

Under the title *Manual of Linguistics* a great amount of material on the phonology of English and other languages has been brought together by *John Clark*, a master in the High School of Dundee (Putnam, $2). After an introductory chapter on the culture and original home of the Aryans, the sound relations in the Indo-European languages are considered at some length. From this subject the author passes to various modifications of vowels and consonants, such as assimilation, shortening, lengthening, prothesis, epenthesis, contraction, labialism, dentalism, rhotacism, reduplication, etc. The nearly related topics ablaut and accent are next considered. The operation of Grimm's law

is then set forth, and the volume ends with two chapters on sound relations in Anglo-Saxon and in middle and modern English. The several laws and processes set forth in the volume are abundantly exemplified by illustrative words.

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POPULAR MISCELLANY.

Spencer-smashing at Washington.—At a meeting of the Washington Society for Philosophical Inquiry held January 23, 1894, the Rev. Dr. Momerie, of London, read a paper on Agnosticism, consisting chiefly of a criticism of Mr. Herbert Spencer and a defense of the current dualistic conception of the soul as the thinking personality or ego considered as distinct from and independent of the body. The paper was discussed by Dr. W. T. Harris and Mr. Lester F. Ward. Mr. Ward's remarks were as follows: "While Dr. Momerie was reading his able paper I could not help thinking to what a remarkable degree the views of Herbert Spencer have become the object of philosophical discussion and public attack. To judge from the opposition to him in all directions one would suppose that his entire system of philosophy was unsound and worthless. No book, no philosophic essay, no form of discussion of any question is complete that does not score him at some point. This society since its organization a year ago has been engaged in an almost uninterrupted onslaught upon his doctrines. Dr. E. L. Youmans, who, when living, was the great American disciple of Spencer, used to characterize those who even at that date had begun to inveigh against him by the name of 'Spencer-smashers,' and since his death the business of Spencer-smashing has continued to increase; but, strange as it may seem, notwithstanding all this opposition the great philosopher will not down. I am not myself innocent of the charge of Spencer-smashing, and I thought these remarks

would come with a better grace from the fact that I have just published what will probably be considered a somewhat severe criticism of Herbert Spencer's Political Ethics. But I am not unmindful of the astonishing power that he has become in the thought of the world, which renders any utterance of his wherein he is wrong so potent for evil. I recently asked a student of Oxford, here for a few days on his winter vacation, how Spencer was regarded at Oxford, and he told me that although his name was rarely spoken and then only in a whisper, as if, on Pope's theory of vice in general, its very utterance might lead to closer acquaintance, nevertheless Spencer was the unseen but overshadowing presence that surrounded the university and which it was considered necessary perpetually to guard against and drive back. I am not finding fault with the widespread opposition to Spencer. Nothing could be worse than to set up a high priest of opinion and bow down to authority. But I have often been amused to see how simple a matter it is supposed to be to refute his doctrines and overthrow his system. And I am disposed to attribute the solidity of his system, and the wonderful resistance which it offers to this perpetual bombardment, to the high degree in which it rests upon the firm foundations of truth. I am myself disposed to follow him with little deviation all the way until he reaches deductive sociology and ethics, and I leave him here only because I believe that, owing to unfortunate early political preconceptions, he has himself left the clear path which his entire system logically requires him to follow. But I did not rise either to approve or disapprove Spencer's philosophy, but simply to draw attention to the kind of man the world has to deal with when it ventures to antagonize his achievements. He fills no chair in any great university, he bears no title from the English crown, he holds no high post of public honor, he boasts no classical scholarship, he speaks no language but his mother tongue, and yet, by a complete mastery of that tongue, and by the sheer power of vigorous and organized thought applied to an 'encyclopedic' acquaintance with all that is worth knowing in the world, he has forced his way into every department of human thought and action. He has invaded science, art, philosophy, literature, morals, and religion in a way and with an authority that have commanded respect and attention, until to-day the eyes of the whole thinking world are centered upon him. I did not know but that Americans were alone in rendering him this unintended homage, but I have learned to-day that it is also the habit of his own countrymen."

The Land of Kashmir.—Giving an account of his Karakorum expedition, Mr. W. M. Conway said that the actual Kashmir was widely different from the land full of all material delights and scenes of idyllic beauty which poets had described. It might, in truth, be described as a "crumpled Sahara," with rocks and precipitous slopes, stony, naked, devoid of moisture or of shade, a grilling, hopeless, impassable wilderness. The only relief to its absolute desert were the patches of artificial irrigation. In this inhospitable region there were great masses of mountains covered with snow, from which sometimes streams issued which created oases here and there of singular fertility. In them alone was any population to be found. The starting point of the expedition was Gilgit—now an important military outpost, but a few years ago unknown to British travelers. Gilgit is about five thousand feet above sea level and affords an exaggerated example of the climate of these regions. It was almost rainless during the months of May and June and the earlier part of July. He had just received a letter from a British officer stationed at Gilgit who gave him a vivid account of a terrible flood which occurred on July 7th and in the course of five days wrought a positive geological revolution. All the bridges and piers were destroyed, and the engineers had to extemporize a bridge with a span of three hundred and forty-six feet. From this cheerless region he emerged into a land of glaciers and traversed the great Hispar, Baltoro, and Biafro glaciers. These great snowfields resembled—though planned on a much vaster scale—those of the Alps. Besides the snowfields there were great areas of moraine—inhospitable deserts covered with large masses of broken stone. There sprang up from them mountain peaks ranging from twenty thousand to twenty-eight thousand feet. In the

Karakorums there were about half a dozen peaks over twenty-four thousand feet. He had himself climbed one of twenty-three thousand feet. These mountains were very different from the Alps, and were mostly in the form of gigantic towers of incredible sharpness—a form in marked opposition to the rounded masses which were the prevalent form of the European mountains.

Distribution of Birds.—The question of the distribution of birds was cited by Canon Tristram, President of the Biological Section of the British Association, as a sphere in which the field naturalist can work to great advantage in studying the operation of isolation in the differentiation of species. Taking as typical examples the Sandwich Islands, thousands of miles from the nearest continent, and the Canaries, within sight of the African coast: in the one we may study the expiring relics of an avifauna completely differentiated by isolation; in the other we have opportunity of tracing the incipient stages of the same process. In the Sandwich Islands there is hardly a passerine bird in the indigenous fauna that can be referred to any genus known elsewhere; and it is now recognized that almost every island of the group possesses one or more representatives of each of these peculiar genera. That each of the islands of this group, however small, should possess a flora specifically distinct suggests thoughts of the vast periods occupied in their differentiation. In the Canary Islands the process of differentiation is only partially accomplished. Yet there is hardly a resident species which is not more or less modified, and this modification is still further advanced in the westernmost species than in those nearest to Africa. We have here the effect of changed conditions of life in four hundred years. What might they not have been in four hundred centuries? The avifauna of the Comoro Islands, to take another insular group, seems to stand midway in the differentiating process between those of the Canaries and the Sandwich Islands. The little Christmas Island, an isolated rock two hundred miles south of Java, only twelve miles in length, has been shown by Mr. Lister to produce distinct and peculiar forms of every class of life, vegetable and animal. Though the species are few in number, yet every mammal and land bird is endemic. In the year 1857–'58 the speaker spent many months in the Algerian Sahara, and noticed the remarkable variations in different groups, according to elevation from the sea and the difference of soil and vegetation. The Origin of Species had not then appeared; but on his return his attention was called to the communication of Darwin and Wallace to the Linnæan Society on the tendencies of species to form varieties, and on the perpetuation of varieties and species by means of natural selection. He then wrote, citing these variations as supplying illustrations of Darwin's and Wallace's theory, but suggesting that, instead of the blending of forms being caused by the two races commingling, rather while the generalized forms remain in the center of distribution, we find the more decidedly distinct species at the extremes of the range, caused not by interbreeding, but by differentiation.

Common Sense on the Labor Question.—The clear light of pure common sense is thrown upon some of the features of the labor agitation in the comments of the London Times upon a conference recently held at Westminster Abbey to consider the troubles in the collieries. The friends of the agitators, it hints, might profitably occupy themselves with trying to get some clear idea of the problems they are so eager to attack. "It would be useful if they would employ their leisure in framing a definition of a living wage a little more precise and intelligible than any they have yet vouchsafed. When they have settled what is a living wage for a miner, perhaps they will try to determine what is a fair day's work, or otherwise will kindly explain where the living wage is to come from in the event of the day's work not being worth it. They would also add greatly to their usefulness and avoid some rather ridiculous declamation if they would master the elementary truths that what are called economic laws are not perverted ethical maxims invented by unchristian economists, but simply generalizations of everyday phenomena. People had been buying in the cheapest market for thousands of years before English economists drew out in formal propositions the consequences of that universal tendency." Before men stand up

to denounce these laws or "doctrines," as they are oddly called, "they ought to understand what they mean, and might even be expected to show that they are never guilty of the unchristian practice of buying in the cheapest market, and so in their degree keeping down wages. Political economy, if these vehement controversialists could only see it, is nothing but common sense and common observation thrown into a methodical and systematized arrangement. If a man has the materials, he need not trouble himself very much about the system. Let the people who demand a living wage in the name of Christianity just begin with an exact inquisition into their own conduct and its consequences. Are they in the habit of paying two guineas for a hat when they can get one as good for thirty shillings? Do they ever knowingly give forty shillings for a ton of coals when they can get coals as good for thirty-five? Of course they do not. Nobody does, but the execrated law of supply and demand is nothing in the world except the working out in the gross of the general habit of getting the best value for one's money. Every one who imagines that he sees a way to get rid of this unchristian law ought to try his panacea on a small scale with his own income. When he is perfectly certain that he uses nothing without being sure that everybody employed in making it has had a living wage, he will be in a better position for lecturing coal-owners. He will also have begun to see that industrial problems can not be settled by invocation of undefined Christian principles."

The Highest Meteorological Station in the World.—The highest meteorological station in the world, before a still higher one was established on El Misti, 19,200 feet, was the Charchani station of the Arequipa Observatory, Peru, a branch of the Harvard College Observatory situated on Charchani Mountain, just below the permanent snow line. As described by Prof. A. Lawrence Rotch, it stands at an elevation of 16,650 feet above the sea, near the brink of a plateau, 3,400 feet below the summit of the mountain. From this brink a precipice drops several hundred feet. Near the louvred shelter in which the instruments are kept a stone hut has been erected, where the person who ascends the mountain to care for the instruments can spend the night, if necessary. The ascent of 8,600 feet from the observatory can be made by mule in about eight hours. Though it is intended to have one of the assistants visit the station each four weeks, regular ascents have not been practicable; consequently, during the year the station has been occupied, only portions of ten months' records have been obtained, and unforeseen stoppages of the self-recording instruments have further reduced the number of complete records to eight. The distance in an air line from the station to the observatory is about eleven miles, and such is the transparency of the air that on a large white disk, which has been placed on the edge of the plateau, a black spot, one inch in diameter, can be seen with the thirteen-inch telescope at the observatory. It has not yet been possible to place instruments on the top of the mountain, though that would be desirable. Two attempts have been made, unsuccessfully, to ascend to that point. The comparatively high temperature and small snowfall on the high mountains of Peru offer opportunities for the establishment of loftier meteorological stations than are afforded by any other country, and the establishment of such a summit station by the Harvard Observatory is the crowning of its remarkable series of stations, extending from Mollendo, on the Pacific coast, along the railroad which crosses the desert of La Joye (4,140 feet), reaching the divide at Vincocaya (14,360 feet), and descending the watershed to Puno, on Lake Titicaca (12,540 feet). Another series, differing little in horizontal distance but relatively greatly separated vertically, for which the observatory at Arequipa and the station on El Misti already furnish steps, would make it possible to obtain data of the greatest value for the study of meteorology.

Anthropology at the University of Michigan.—The first work in anthropology at the University of Michigan was begun in the second semester of the college year 1891–'92, with a course in museum laboratory work in American archæology, under the direction of Prof. F. W. Kelsey. The course was attended by two students. Provision was made for the exhibition of the collections in the possession of the institution, and soon

had to be added to. It was then found that the university had a much more valuable collection than was at first supposed. Among its most interesting and instructive features were a typical lot of about forty neolithic implements from Denmark; stone and pottery specimens illustrating the archæology of Michigan; potsherds and pottery vessels from the islands at the mouth of the Amazon; ancient Peruvian vessels from Ancon and Pacasmayo; pottery vessels from the East Indies; skulls, including some of the perforated crania described by Henry Gillman, so mounted that they may be examined on all sides and measured without handling; stone hammers or mauls from the ancient copper pits at Isle Royale, Mich.; the De Pue collection of implements from the surface of the immediate neighborhood of the university; and casts from the Smithsonian collections, with descriptions. Several prehistoric village sites have been discovered near Ann Arbor, which, it is hoped, may soon be thoroughly examined. A survey has been made of one of the prehistoric "garden beds" at Kalamazoo. As yet the work of the museum has been chiefly confined to archæology, but it is expected that, as the department develops, other phases of anthropological science will be studied.

The Conditions of Rain-making.—The conditions of successful rain-making, as defined by Prof. A. Macfarlane, of the University of Texas, in the light of Mr. John Aitken's experiments on fogs and dust—not in a small portion of the atmosphere cut off from the rest by means of an air-tight receiver, but on a large scale in the unbounded atmosphere—are: "If the air operated on is at a temperature higher than its temperature of saturation, it must be cooled down to that temperature. Further, when the moisture condenses it gives out latent heat, which tends to arrest the process; this latent heat must be removed. It is not, as some rain-makers have imagined, 'Pull a trigger; Nature will do the rest.' The only trigger-pulling which experiments warrant as possible consists in supplying the necessary fine dust for nuclei, so that condensation may take place without delay when the air is cooled to its temperature of saturation; or in supplying fine dust from such a substance as common salt, which has a chemical affinity for water and may be able to accelerate slightly the falling of a shower. Suppose we take a cubic mile of the air upon which Dyrenfurth operated on the night of Friday, November 25, 1892. The record at the weather office in San Antonio, at 8 P.M., gave the temperature of the air as 72° Fahr., and the dew point as 61° Fahr. To cool down a cubic mile of that air to the dew point would require the abstraction of as much heat as would raise eighty thousand tons of water from the freezing point to the boiling point. To cool it down another eleven degrees would require as much more heat to be abstracted. The amount of water set free would be twenty thousand tons, which, spread over a square mile, would give about 1·4 pound per square foot, or $\frac{27}{1000}$ of an inch of rainfall. The amount of latent heat set free by the condensation of that amount of water would raise one hundred thousand tons of water from the freezing point to the boiling point; and it would be necessary to absorb this heat in order that the rain-making might go on. I have supposed the cubic mile of air to be kept constant; if the air operated on is constantly changing, the task becomes one of infinitely greater difficulty." It is hardly necessary to say that Prof. Macfarlane considers the professional rain-makers, the proceedings and pretensions of eight of whom he reviews in his paper, as "no better than the medicine men of the Indians."

Anomalies in Weight.—The anomalies in weight at different points on the surface of the earth, which have been recognized for a considerable time, have been attributed to corresponding anomalies in the figure of the earth; to the insufficiency of the formulas for reduction to sea-level; to the unequal distribution of masses; or to inexact observation. A study of the subject by the French commander Defforges, which included forty-one observations at twenty-five stations of different latitudes and elevations, shows that weight is distributed very unequally over the globe; that Clairaut's law, true as a whole, is nearly always marked by notable anomalies; that weight, on the shores of different seas, presents feeble anomalies, constant, and consequently characteristic, on

the same shore; that a considerable excess of weight prevails in islands; that the rule is inverse on the continents, and the deficiency seems to increase in proportion to the altitude and the distance from the sea; that anomalies in weight, positive in Spitzbergen, Scotland, and Corsica, become negative in continental France and Algeria; that continental anomalies increase with the altitude and the distance from the sea; that anomalies in weight can not be attributed to anomalies in the shape of the earth, and the explanation of the irregularities must be asked of geology; and that these results are confirmed by comparing Anglo-Indian and French measurements.

Relations of Floras and Geological Formations.—It is generally recognized that certain floras and certain geological formations go together; and the plants are spoken of as characteristic of the formation. One of the best recognized of these characteristic floras is that of the pine barrens of New Jersey, which was observed several years ago to extend northward into Staten Island and Long Island. In these places the flora growing upon the cretaceous and that growing upon the drift are so distinct that the fact could hardly fail to attract the attention even of the superficial observer. More recently many characteristic species of this pine-barren flora have been recognized as growing in southern Rhode Island, on Block Island, near New Bedford, Mass., on Martha's Vineyard, and Nantucket, and even as far north as Canada. The question arises, How did it spread to the places in New England where it is now found? It is a southern flora, and is characteristically American. Its course of migration was from the south, either by way of the mainland through New York and Connecticut, or else across the salt water from Long Island. The subject has been studied in the light of the geology and topography by Mr. Arthur Hollick, who concludes that there was during a considerable period of time a continuous strip of land, except for the river outlets, "all the way from New Jersey to Massachusetts, separated from the mainland by a body of water occupying the trough scooped out by the glacier, which, in its present depressed and widened condition, we now call Long Island Sound, but which was then a fresh-water lake or broad river." Afterward the land underwent oscillations in level, in the course of which the glacial moraine was eaten away in places by the sea, and the present series of islands and shoals was formed.

Morals and the Nervous System.—One case of agreement between the practical wisdom of the Bible and the results arrived at by modern science was recently made the basis of a sermon by Rev. G. R. Dodson, of Alameda, Cal. Mr. Dodson described the passage of a current of nervous energy through some portion of the nervous system as being a part of every action of thinking or willing. When we think about doing something, for instance, there is a comparatively faint excitation of the nervous system; a stronger impulse causes the act to be done. Thought and feeling are thus actions which do not get beyond the limits of our own bodies. "How this re-enforces," says Mr. Dodson, "the teaching of Jesus, that not the overt act alone constitutes the crime, but that the sin is committed when the desire is cherished in the heart! Indeed, the desire is the action incomplete, restrained within the limits of the body. In I John, iii, 15, it is said, 'He that hateth his brother is a murderer.' This is physiologically true; hate is murder on the way. Lust is adultery begun." Another important relation between morals and the nervous system is that repetition makes any action easier. The nerve currents meet with considerable resistance at first, but, by repeatedly going over the same paths, they "hew out" and "widen" the ways, so to speak, until they become lines of small resistance and the actions become easy. From the close connection between thinking about an action and directing the body in the performance of it, there comes a surprising result. To be ever thinking of doing anything is to be always beginning to do it. The continual use of the nervous system in thinking of some evil deed is really practicing the deed itself—is making more pervious to the nerve currents the nerve paths which would be used in the performance of the action. Thus it is that some time, when off guard, the temptation (the physiological stimulus) comes, a surplus of nervous energy is discharged along these

lines of least resistance, and the deed is done. In this way many young people, who were supposed to be the models of moral perfection, have, to their own surprise as well as that of their friends, suddenly fallen. In such cases the evil desire, which had before been kept within the limits of the body, is simply continued and completed in the outward world. With what force come to us the words, "Blessed are the pure in heart"! and, again, "Whatsoever things are true, honorable, just, pure, lovely, and of good report, whatever is praiseworthy and virtuous, *think on these things*." Physiological psychology gives the strongest emphasis to these old moral precepts. Nerve paths used constantly in true thinking and noble sentiment become the lines of least resistance, while those for ignoble thought and feeling become like unused, neglected roads —difficult to travel. It thus becomes constitutionally easy to live nobly, and organically difficult to do wrong. In the second place, when evil thoughts are aroused they are at once automatically negatived (inhibited) by good impulses, and without any action of the will there is an instinctive recoil from the evil suggestion.

Bacteriology and Public Health.—In connection with the relation between bacteriology and public health, Prof. Frankland referred, in the discussion in the British Association, to investigations by himself and others on the purification of drinking waters by subsidence, filtration, and precipitation. He pointed out that great misconception prevailed as to the real value of water analyses, the object of which was to show whether a water was liable to become a source of danger at any time, and not whether it was actually dangerous at a particular moment. Recent methods had, however, made it possible to detect the special bacteria of typhoid and cholera when present in a drinking water. Contrary to the common belief, bacteria could retain their vitality in ordinary water for weeks, while the spores were not destroyed for months; but different species varied in this respect. Sewage was best treated by intermittent filtration through soil. This process removed the bacteria more rapidly and completely than it removed dissolved organic matter. Later investigations had confirmed the early observations of Downes and Blount on the susceptibility of bacteria to the action of light, and it appeared that the well-known disinfecting power of the sun's rays was due to the fact that they actually destroyed bacteria and their spores, the rate of destruction depending on the nature of the organism and the condition in which it was placed.

Coal Dust and Explosions.—In a paper on Explosions in Coal Mines, Prof. H. B. Dixon said that the statement that explosions do not travel through damp parts of a mine has been confirmed, and that it is practicable to localize and isolate explosions by always keeping certain sections of the mine damp. Recent experiments by Mr. Hall and by an Austrian committee agree with some earlier experiments in showing that different coal dusts vary enormously in their degree of inflammability, and that mixtures of some dusts with air are violently explosive if ignited by means of a large flame. The great variation in the properties of coal dusts probably accounts for the difference between the reports from different districts. Whether it is true that coal dust and air alone are explosive, or that the presence of small quantities of fire damp is essential, must be shown by further investigations on the nature of the dust from different mines, the degree of danger attaching to the use of different explosives, and the efficiency of various methods of laying the dust in mines.

Education and "Short Cuts to Utopia."—The question whether the general education of the masses is on the whole a good thing is under discussion in the English papers. A writer in one of them attributes to it "that wonderful readiness to believe in short cuts to Utopia" which is one of the marked and unmistakable features of our day. The Spectator disputes this, and cites the evidence of history as being all the other way. "The most desperate attempt ever made to realize heaven on earth by a short cut was made by the followers of John of Leyden, who were for the most part as devoid of what is now called education as the beasts of the field. There never was such a dream of the short cut to Utopia as was

dreamed at the beginning of the French Revolution; and the agents of that revolution were for the most part peasants and artisans entirely innocent of book learning, who, even in Paris, were accustomed to have their wild newspapers read to them; . . . it was before her people were educated that Prussia conceded the agrarian law on which her state has ever since been organized, and which her people certainly regarded as their short cut to happiness. On the other hand, the effect of John Knox's system of education in Scotland has been to make the country north of the Tweed for two hundred years singularly averse to social dreams; while the Prussians, educated for seventy years—two clear generations—have been the gravest and most sensible and self-sacrificing people of the continent. We question if, even in England, the people are half as dreamy as they were in 1830, when they were profoundly ignorant, or if the French working class, socialist as it is, is half as confident of Utopia as it was forty-five years ago. The American school system, which extends everywhere, has produced a race whose special characteristic is sense so hard that they bear the most provoking evidence of the tendency of wealth to accumulate in few hands without interfering, and shoot down the uneducated foreigners who form the strength of their anarchist party with a decision which, at all events, is far removed from dreaminess."

NOTES.

An interesting study is published by J. Walter Fewkes of the legend of the destruction of the Tusayan pueblo of Awátobi current among the Hopi Indians, and of his researches on the site of the pueblo for the illustration and verification of the story. The destruction was effected by the Hopis about the beginning of the eighteenth century. The investigation was carried on in connection with the Hemenney Southwestern Archæological Expedition.

Vertical writing, which was described and illustrated in the November Popular Science Monthly, has already gained a foothold in Canada, and is attracting considerable attention in the United States. The Educational Review (St. John, N. B.) states that Mr. A. F. Newlands, supervisor of penmanship in the public schools of Kingston, Ontario, introduced it into the schools of that town a year ago. It is also taught and favored in many schools of Montreal and Toronto. It has been given the preference in the public-school system of Nova Scotia, having entirely displaced sloping writing in Halifax. It is also taught in the Halifax Ladies' College. Among the librarians of the United States it is no new thing, having been adopted several years ago by many of them for writing catalogue cards on account of its superior legibility.

Darwin appears, from a communication in Nature by Mr. Kumusagu Minakata, to have been anticipated more than a thousand years in announcing the theory of the adaptation of the color of animals to that of their surroundings, by Twang-Ching-Shih, a Chinese philosopher of the ninth century, who, having described the habits of the trap-door spider (or "tumbling defender") and observed that the lid of its nest is colored like the ground, adds: "In general, birds and animals necessarily conceal forms and shadows by their assimilation with various objects. Consequently, a snake's color is similar to that of the ground, the hare in the imperator grass is unavoidably overlooked, and the hawk's hue agrees with that of the trees."

An ingenious device has been contrived by Dr. A. Cancani, of Italy, for registering the precise time when an earthquake shock occurs. The seismograph is so arranged as to take an instantaneous photograph of the face of a chronometer at the instant of the shock. An adjustment of levers and batteries and magnet is thrown into gear by the shock, so that an incandescent electric lamp is lighted automatically for about a quarter of a second, while the image of the clock is established upon the photographic plate.

An investigation has been made by H. M. Bernard of the comparative morphology of spiders, the results of which he hopes shortly to have ready for publication. These results, he represents, "go far to establish that classification which ranks the arachnids as an independent group of the tracheate arthropods, as distinguished from that which would deduce them from the specialized crustacean *Limulus* through the specialized arachnid *Scorpio*."

The disappearance is reported of the voles or field mice which infested the farms of Scotland a year or two ago to such an extent that the evil they wrought and threatened became a serious economical problem. They were first observed a few years before 1890; multiplied rapidly till the summer of 1892, when they began to decrease, and ceased to be formidable in the summer of 1893. On some farms the normal numbers remain, but on others hardly one is to be seen. The disappearance appears to be general over the whole country. Various causes

have been suggested for their vanishing, among the chief of which the farmers and shepherds name the work of such natural enemies as the owl, kestrel, rook, blackhead gull, buzzard, stoat, and weasel—animals which foolish man is industriously trying to exterminate.

According to Meehan's Monthly, the large majority of plants are scentless, and probably not one tenth of the hundred thousand flowering plants known to botanists are odorous. Of the fifty known species of the mignonette family, only the one so highly prized in our gardens is fragrant, and only about a dozen of the one hundred species of violet are scented. In many large genera the scentless varieties are as one hundred to one, and sweet-smelling varieties are comparatively rare among our wild flowers.

It was observed by the late Mr. Wollaston that most insects inhabiting the Atlantic islands are either strongly winged or incapable of flight. The explanation of the phenomenon is found in the fact that insects exposed to gales are very liable to be blown out to sea. Hence it is almost equally to their advantage either to be gifted with strong enough powers of flight to be able to make their way back when they have been blown away, or never to fly at all, and thus escape the risk of being blown away.

OBITUARY NOTES.

Prof. Heinrich R. Hertz, of the University of Bonn, who won fame by his demonstration of the intimate connection of light and electricity, died at Bonn, on New-Year's day, of blood poisoning induced by a chronic disease of the nose. He was born at Hamburg on the 22d of February, 1857; entered the Engineering School in 1875; afterward devoted himself to physics, studying in Munich and Berlin; became an assistant to Helmholtz in 1875; settled in Kiel in 1883 as a *privat docent* in theoretical physics; was appointed in 1885 Professor of Physics in the technical Hofschule in Carlsruhe; and in 1885 succeeded Clausius as Professor of Physics at Bonn. The apparatus with which he made his famous demonstration was shown at the Electrotechnic Exhibition at Hamburg, where it attracted much attention, particularly from men of science. His own account of his demonstration of the identity of light and electricity was published in volume xxxviii of The Popular Science Monthly, December, 1890. We hope, at some future time, to publish a biographical sketch and portrait of him.

The distinguished Belgian zoölogist, Prof. Pierre Joseph van Beneden, of the University of Louvain, died in that city, January 8th, in the eighty-fifth year of his age. His first scientific position was that of keeper of the Natural History Collections at Louvain. In 1835 he was made an assistant professor at the University of Ghent, and in the same year professor in the Catholic University of Louvain. He was author of a large number of zoölogical and biological papers, particularly on parasites, worms, etc.; joint author with Du Mortier of the Natural History of the Fresh-water Polyzoa, and with Paul Gervaise of the Zoologie Médicale; and author of Recherches sur le Faune littorale de Belgique, and of the book on Animal Parasites and Messmates in the International Scientific Series. He had artistic skill, and contributed illustrations to his works.

Prof. Arthur Milnes Marshall, of Owens College, Manchester, was killed, December 31, 1893, by a fall on the peak of Scafell, Cumberlandshire, England. He was born in 1852; entered St. John's College, Cambridge, in 1871, where he was one of the earliest students in the school of biology, and whence he was graduated on completing the course; entered upon the study of medicine at St. Bartholomew's Hospital in 1876; and was appointed Professor of Zoölogy in Owens College in 1879. He was author of a series of papers on the Cranial Nerves, on the Pennatulidæ, and on the Nervous System of Antedon, and of works on Vertebrate Embryology, the Frog, and Practical Zoölogy; was secretary and afterward chairman of the board of studies of Victoria University; was a Fellow of the Royal Society; and was an active worker in the university extension movement. He had ascended the mountain with a party on the day of his death, and was standing at a point higher than the others, when a rock fell, carrying him with it.

The eminent zoölogist and paleontologist, Dr. Paul Henri Fischer, who died in Paris, November 29, 1893, was born in Paris in 1835; became Demonstrator of Paleontology in the Museum of Natural History of Paris in 1861; and rose to be assistant naturalist there. From 1856 he edited the Journal de Conchyliologie in collaboration with M. Crosse. He studied very successfully the marine animals of the coast of France and their geographical and bathymetric distribution. He and the Marquis de Folin, examining the Fosse du Cap Breton in the Gulf of Gascony, discovered a large number of forms previously unknown, some of which resembled fossil forms. With M. Delesse he made researches on the submarine sediments of the French shores. He took part in the expeditions of the Travailleur and the Talisman. His works, books, pamphlets, and memoirs include three hundred titles.

The death, at Kiel, in November, 1893, is reported of Baron von Bulow, founder of the Bothkamp Observatory, the first observatory in Germany devoted to astro-physical researches.

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ARTICLES MARKED WITH AN ASTERISK ARE ILLUSTRATED.

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Books noticed:

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VOL. XLIV.] ESTABLISHED BY EDWARD L. YOUMANS. [NO. 1.

THE POPULAR SCIENCE MONTHLY.

NOVEMBER, 1893.

EDITED BY WILLIAM JAY YOUMANS.

CONTENTS.

NEW YORK:
D. APPLETON AND COMPANY,
1, 3, AND 5 BOND STREET.

SINGLE NUMBER, 50 CENTS. YEARLY SUBSCRIPTION, $5.00.

Entered at the Post-Office at New York, and admitted for transmission through the mails at second-class rates.

FORTY-EIGHTH ANNUAL REPORT OF THE

NEW YORK LIFE INS. CO.

Office: 346 & 348 Broadway, New York.

JANUARY 1, 1893.

This is the only Company holding an Official Certificate of Examination, of recent date, from the State Insurance Department. The Assets, Accounts, and Surplus to Policy-holders have been certified to under the seal of the State by the Insurance Superintendent.

ASSETS.

Real Estate	$12,531,016 75	
Stocks and Bonds	86,680,177 51	
Bonds and Mortgages	24,236,785 51	
Loans secured by collaterals	3,916,000 00	
Premium Loans	1,096,850 03	
Cash in Office and in Banks and Trust Companies	4,201,283 68	
Interest and Rents due and accrued	971,810 14	
Net Amount of uncollected and deferred Premiums	3,865,275 37	
TOTAL ASSETS		**$137,499,198 99**

LIABILITIES.

Reserve, or Value of outstanding Policies	$119,075,888 00	
Other Liabilities	1,618,362 89	
Total Liabilities		$120,694,250 89
Surplus, being the same amount which will be shown to be the Company's Surplus by the Annual Report of the New York State Insurance Department as of December 31, 1892		$16,804,948 10

INCOME.

Total Premium Income	$25,040,113 93	
Interest, Rents, etc	5,896,476 90	
Total Income		$30,936,590 83

DISBURSEMENTS.

Losses paid		$7,896,589 29	
Endowments paid		1,114,301 99	
Annuities, Dividends, Surrender Values, etc		4,984,121 05	
Total paid Policy-holders	$13,995,012 33		
Commissions		4,178,316 60	
Agency Expenses, Physicians' Fees, Advertising and Printing		1,851,246 18	
Taxes, Salaries, and other Expenses		1,629,715 65	
Total Disbursements			$21,654,290 76

Number of Policies issued during 1892, 66,259. New Insurance, $173,605,070.

Total number of Policies in force January 1, 1893, 224,008. Amount at Risk, $689,248,629.

NOTE AS TO STATEMENT.—The above Statement corresponds in all respects with the Official Report of the Company as it will be published by the State Insurance Department. No Assets, not acceptable under the law of the State, or the Regulations of the Department, are included, and the SURPLUS ($16,804,948 10) IS THE EXACT SUM THAT WILL BE SHOWN BY THE SUPERINTENDENT'S ANNUAL REPORT.

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FORTY-EIGHTH ANNUAL REPORT OF THE

NEW YORK LIFE INS. CO.

Office: 346 & 348 Broadway, New York.

JANUARY 1, 1893.

This is the only Company holding an Official Certificate of Examination, of recent date, from the State Insurance Department. The Assets, Accounts, and Surplus to Policy-holders have been certified to under the seal of the State by the Insurance Superintendent.

ASSETS.

Real Estate	$12,531,016 75	
Stocks and Bonds	86,680,177 51	
Bonds and Mortgages	24,236,785 51	
Loans secured by collaterals	3,916,000 00	
Premium Loans	1,096,850 03	
Cash in Office and in Banks and Trust Companies	4,201,283 68	
Interest and Rents due and accrued	971,810 14	
Net Amount of uncollected and deferred Premiums	3,865,275 37	
TOTAL ASSETS		**$137,499,198 99**

LIABILITIES.

Reserve, or Value of outstanding Policies	$119,075,888 00	
Other Liabilities	1,618,362 89	
Total Liabilities		$120,694,250 89
Surplus, being the same amount which will be shown to be the Company's Surplus by the Annual Report of the New York State Insurance Department as of December 31, 1892		$16,804,948 10

INCOME.

Total Premium Income	$25,040,113 93	
Interest, Rents, etc	5,896,476 90	
Total Income		$30,936,590 83

DISBURSEMENTS.

Losses paid		$7,896,589 29	
Endowments paid		1,114,301 99	
Annuities, Dividends, Surrender Values, etc		4,984,121 05	
Total paid Policy-holders	$13,995,012 33		
Commissions		4,178,316 60	
Agency Expenses, Physicians' Fees, Advertising and Printing		1,851,246 18	
Taxes, Salaries, and other Expenses		1,629,715 65	
Total Disbursements			$21,654,290 76

Number of Policies issued during 1892, 66,259. New Insurance, $173,605,070.

Total number of Policies in force January 1, 1893, 224,008. Amount at Risk, $689,248,629.

NOTE AS TO STATEMENT.—The above Statement corresponds in all respects with the Official Report of the Company as it will be published by the State Insurance Department. No Assets, not acceptable under the law of the State, or the Regulations of the Department, are included, and the SURPLUS ($16,804,948 10) IS THE EXACT SUM THAT WILL BE SHOWN BY THE SUPERINTENDENT'S ANNUAL REPORT.

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TRUSTEES.

VOL. XLIV.] ESTABLISHED BY EDWARD L. YOUMANS. [NO. 3.

THE POPULAR SCIENCE MONTHLY.

JANUARY, 1894.

EDITED BY WILLIAM JAY YOUMANS.

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Office: 346 & 348 Broadway, New York, U. S. A.

ORGANIZED 1845.

A Purely Mutual Company having no Capital Stock. All Profits to Policy Holders.

JANUARY 1, 1894.

ASSETS.

Real Estate, including 11 Office Buildings and 85 pieces of property purchased under foreclosure	$13,139,049 93	
Stocks and Bonds owned (market value)	89,992,636 45	
Bonds and Mortgages	25,805,235 20	
Loans secured by collaterals (market value of Securities held as collateral, $3,349,425 67)	2,428,966 67	
Premium Loans on existing Policies (the reserve on these Policies, included in Liabilities, amounts to over $8,000,000)	3,757,681 71	
Cash in Office and in Banks and Trust Companies	7,012,468 93	
Interest and Rents due and accrued	1,455,908 02	
Net Amount of uncollected and deferred Premiums	5,108,834 30	
TOTAL ASSETS		**$148,700,781 21**

LIABILITIES.

Reserve on outstanding Policies, at Actuaries' 4 per cent as per Certificate of New York State Insurance Department, including Additional Reserve on Annuities and Accumulation Policies voluntarily set aside by the Company	$129,862,448 00	
Losses awaiting proof or payment	1,330,854 37	
Matured Endowments due and unpaid (claims not presented)	122,007 76	
Annuities due and unpaid (claims not presented)	22,770 02	
Unpaid Dividends due Policy-holders	134,533 64	
Premiums paid in advance	134,554 82	
Trust Deposit, held for account of beneficiaries under terms of Policies	67,982 42	
Total Liabilities		$131,675,151 03
Net Surplus per Certificate of Insurance Department		$17,025,630 18

INCOME.

Premium Receipts	$27,488,657 44	
Interest, Rents, etc	6,374,989 51	
Total		$33,863,646 95

DISBURSEMENTS.

Death Claims paid		$8,440,093 46	
Endowments matured and discounted, paid		1,083,445 95	
Annuities paid		1,407,256 95	
Dividends paid		1,744,391 78	
Paid for Purchased Policies		2,359,062 13	
Installment paid on Trust Deposit		4,200 00	
Total amount paid to Policy-holders	$15,038,450 27		
Commissions, Brokerages, and Payments to Agents		4,579,880 89	
Agency Expenses		1,079,342 28	
Physicians' Fees, Advertising, and Rent		883,167 96	
Salaries to Officers and Employees		765,469 32	
Law and Office Expenses, Stationery and Printing, Traveling and other Expenses		761,117 52	
Taxes in the State of New York and other States		317,296 97	
Total Disbursements			$23,424,725 21

INSURANCE ACCOUNT.	No.	Amount.
New Policies issued in 1893 (Declined, 10,395, $28,569,757)	85,568	*$223,848,991 00
In Force December 31, 1892	224,008	$689,248,629 00
In Force December 31, 1893	261,992	779,156,678 00
Gain in 1893	37,984	$89,908,049 00

* Not including policies revived, paid-ups, or reversionary additions.

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